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CALIBRATION CONTROL
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VIKING LABORATORIES INC.

CONCORD INSTRUMENT
DIVISION

MODEL 6051

FREQUENCY COUNTER

SYSTRON DONNER

Concord Instrument Division

INSTRUCTION MANUAL

CONCORD INSTRUMENT
DIVISION

MODEL 6051

FREQUENCY COUNTER

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SYSTRON DONNER CORPORATION

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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

The SD Model 6051 is a portable, half-rack, frequency counter capable of automatically measuring signal frequencies ranging from 20Hz to 200MHz. Extensive use of integrated circuits and other solid-state components ensures excellent reliability and trouble-free maintenance.

The Model 6051 Frequency Counter provides the following operating features:

1. An easily read storage-type display which permits the initial reading to be observed while another is being made.
2. Direct reading of frequency with no front panel adjustment necessary.
3. Automatic units of measure and decimal point location.
4. Completely remote programmable: programming inputs for all front panel controls and attenuator switch (optional).
5. BCD recorder output (optional).
6. Unit can be operated on either 115V or 230V ac line.

1.2 FUNCTIONAL DESCRIPTION

The Model 6051 features a new high sensitivity, high input impedance 200MHz amplifier to offer unparalleled performance. The basic seven-digit instrument receives its input on one input connector.

1. BNC - This 20Hz to 200MHz input channel features 10mV rms sensitivity and one meghom impedance. Input signals may be attenuated by factors from 1 to 1000, in decade steps.

1.3 SPECIFICATIONS

Table 1.1 lists the specifications applicable to the Model 6051:

TABLE 1.1 SPECIFICATIONS

Low-Frequency Range Input	Frequency Range:	20Hz to .2GHz.
	Type of Signal:	CW.
	Sensitivity:	10mV rms.
	Maximum Input Without Damage:	600V dc, 200V rms.

TABLE 1.1 SPECIFICATIONS (Cont'd)

	Input Impedance:	1MΩ.
	Input Connector:	Type BNC.
	Accuracy:	±1 count ±time base accuracy.
	Resolution:	100kHz to 0.1Hz in decade steps.
	Reads In:	kHz or MHz.
Time Base	Crystal Frequency:	1MHz.
	Stability:	±2 parts in 10^6/month.
	Temperature:	Less than ±1 part in 10^5 from +15°C to +35°C; less than 3 parts in 10^5 from 0°C to +50°C.
	Line Voltage:	Less than 1 part in 10^6 for 10% change in line voltage specified.
	Output Frequency:	1MHz, 3V p-p minimum open circuit; source impedance 2000Ω maximum.
	External Input:	1MHz sinewave, 1V rms into 1000Ω, 10V rms maximum.
	Higher Stability Available:	See options listed.
General	Registration:	7 digits, expandable to 9.
	Reads In:	kHz or MHz with positioned decimal point.
	Display Storage:	Provides a continuous display of most recent measurement.
	Rear Panel:	1MHz internal/external switch, BNC connector for 1MHz input or output, line cord, oscillator adjustment, fuse.
	Operating Temperature:	0°C to +50°C.

TABLE 1.1 SPECIFICATIONS (Cont'd)

	Dimensions:	3-1/2" high x 8-3/8" wide x 13" deep.
	Weight:	10 lbs. net (15 lbs. shipping).
	Power:	115V/230Vac, 50 to 60Hz.
Options	B3	Aging Rate: < 3 parts in 10^8/24 hours. Long-Term Aging Rate: < 3 parts in 10^8/30 days. Short-Term Aging Rate: < 1 part in 10^{10}rms/1s average.
	B	Aging Rate: < 1 part in 10^9/24 hours. Long-Term Aging Rate: < 3 parts in 10^8/30 days. Short-Term Aging Rate: < 1 part in 10^{10}rms/1s average.
	B4	Aging Rate: < 5 parts in 10^{10}/24 hours. Long-Term Aging Rate: < 1.5 parts in 10^8/30 days. Short-Term Aging Rate: < 5 parts in 10^{10}/1s average.
	E & EE	Additional decade indicator to increase count capacity to 8 (E) or 9 (EE) digits.
	D3	1-2-4-8 BCD Output: Coded output information of front panel reading appears at rear panel connector. Positive logic "1" state level at +5V nominal, "0" state level at 0V ±0.5V; a +5V print command at the end of each conversion, positive reference level is +4V, negative reference level is +1V with a column capacity equal to the number of digits.
	P	Remote programming of range, resolution and attenuators. T^2L, DTL compatible.

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

Procedures for inspection and initial installation of SD Model 6051 are outlined below. Reshipment instructions have been included should the instrument require return to Systron-Donner Corporation.

2.2 RECEIVING INSPECTION

Before accepting the instrument from the shipper, inspect the shipping container for signs of external damage. Any sign of such damage must be noted by both the shipper and customer; then, should be reported to the insurance investigator.

As soon as the instrument is unpacked, inspect it for shipping damage. Check for scratches or dents, broken or cracked knobs, and damaged connectors. Should any damage be found, notify your nearest Systron-Donner representative -- do not use the instrument until instructed to do so by the representative.

2.3 INSTALLATION

Initial installation of the Model 6051 includes power connection and verification of internal cooling.

2.3.1 Power

The Model 6051 may be operated from a 115 or 230-volt ac (±10%) power source. Conversion from one source to another is performed by changing jumpers on the power transformer (See Figure 2.1).

The instrument is factory supplied with a 1A, 3AG fuse for 115V operation. Be sure to replace this fuse with a .5A, 3AG fuse when operating with 230V.

CAUTION

Before connecting instrument into ac power line, be certain that transformer is wired for proper power.

The Model 6051 is equipped with a standard three-conductor power cord that automatically grounds the unit when a matching power outlet is available. An adapter which provides the instrument ground should be used whenever the power cord is connected to a two-conductor outlet.

2 3 2 Cooling

The Model 6051 Counter uses forced air cooling. The air intake is located on the rear panel of the instrument. Make sure the air intake filter is clean and in place before applying power to the instrument. Under no circumstances should the air intake be obstructed while the instrument is operating.

2 4 RESHIPMENT

Should it become necessary to reship the instrument, contact the nearest Systron-Donner field office for shipping instructions. If possible, use the original packaging materials, or replace the packing in accordance with MIL-P-116 and MIL-E-17555E. The field office can provide materials similar to those used for original factory packaging. All correspondence should refer to the full nomenclature and serial number of the instrument.

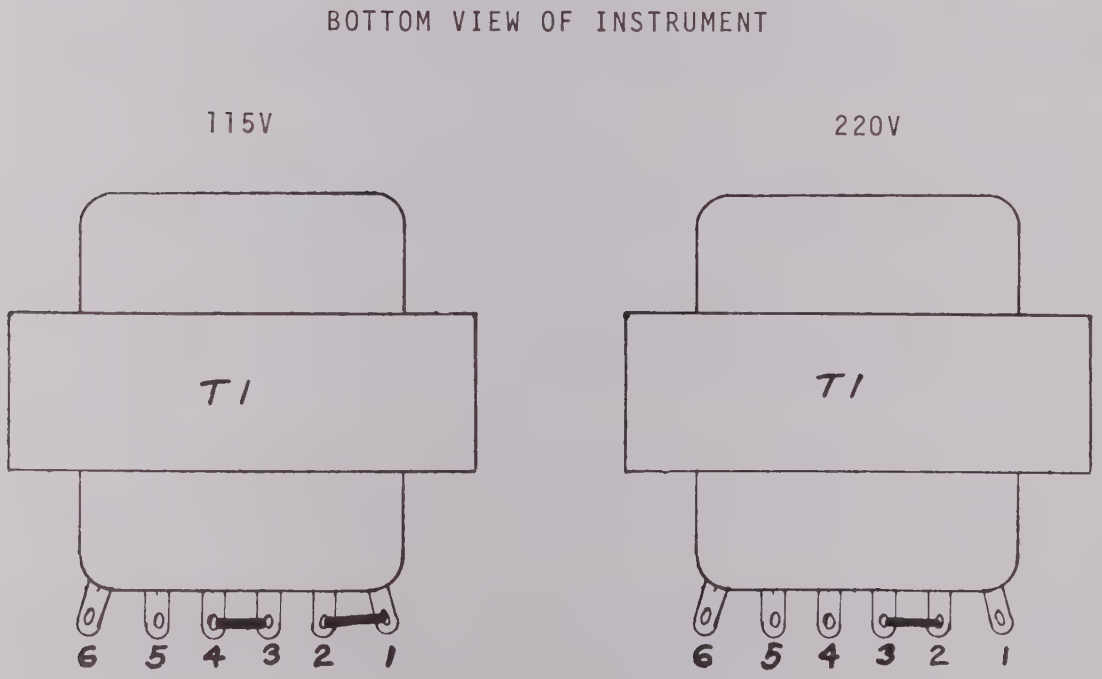


FIGURE 2.1 TRANSFORMER JUMPER POSITION FOR POWER CHANGE

CHAPTER 3
OPERATION

3.1 INTRODUCTION

This section describes the SD Model 6051 controls, connectors, and indicators. Initial turn-on and operational checks are included,along with step-by-step operating procedures listing each basic function of the counter.

3.2 CONTROLS, CONNECTORS, AND INDICATORS

Figures 3.1 and 3.2 illustrate the Model 6051 front and rear panel controls, connectors, and indicators. Table 3.1 and 3.2 provide a description of these functions.

TABLE 3.1 FRONT PANEL

FIGURE	INDEX	NAME		FUNCTIONS
3.1	1	POWER (pushbutton)		Applies power to the instrument.
3.1	2	TEST (pushbutton)		Applies the 1MHz internal oscillator frequency to the internal circuits for test.
3.1	3	RANGE 20Hz - 200MHz ATTENUATOR (pushbutton)	X1 X10 X100 X1k	Attenuates the input applied to the 1MΩ, 20Hz-200MHz BNC connector by a factor of 1 (X1), 10 (X10), 100 (X100), and 1000 (X1k).
3.1	4	DISPLAY (indicator)		Digital indicators and polarized window provide glare-free viewing of measurement.
3.1	5	20Hz - 200MHz 1MΩ (connector)		Type BNC provides signal input connection for the 20Hz - 200MHz range of measurement.
3.1	6	GATE (indicator)		Light-emitting diode (LED) indicates when the count gate is open or closed.

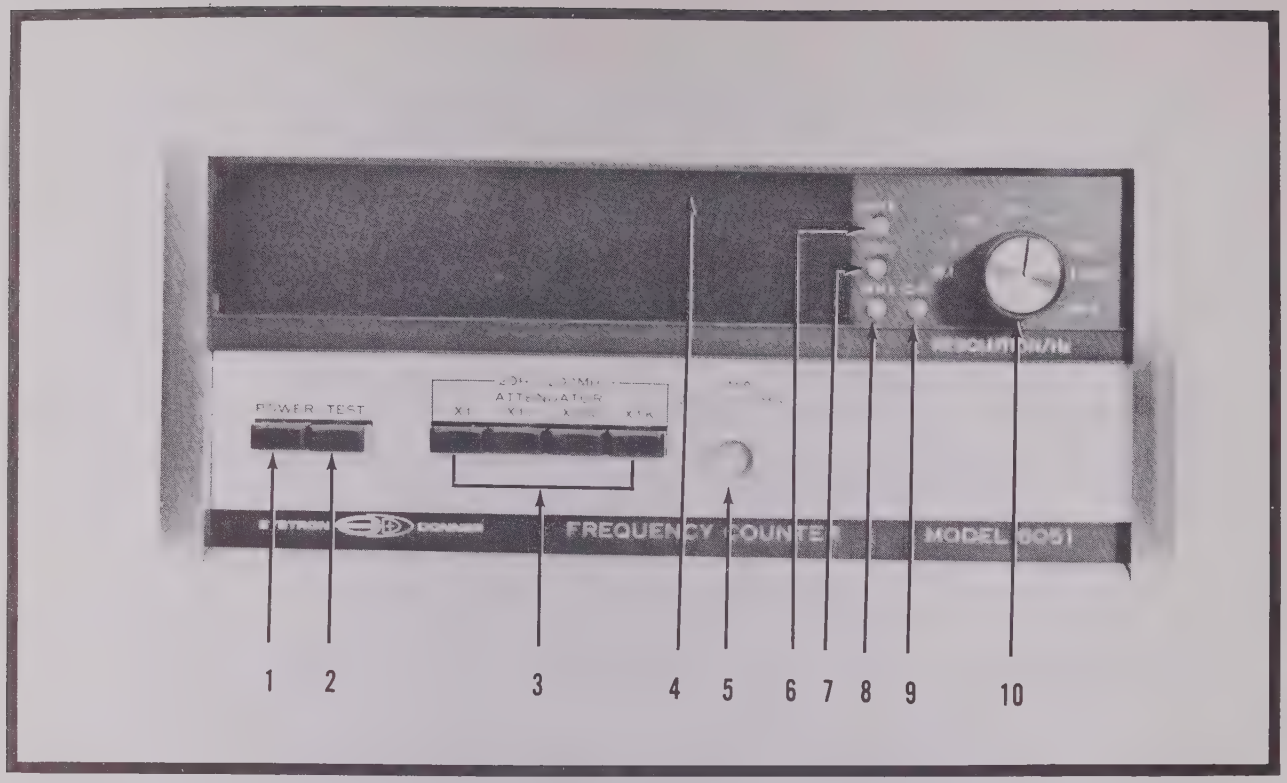


FIGURE 3.1 FRONT PANEL, MODEL 6051

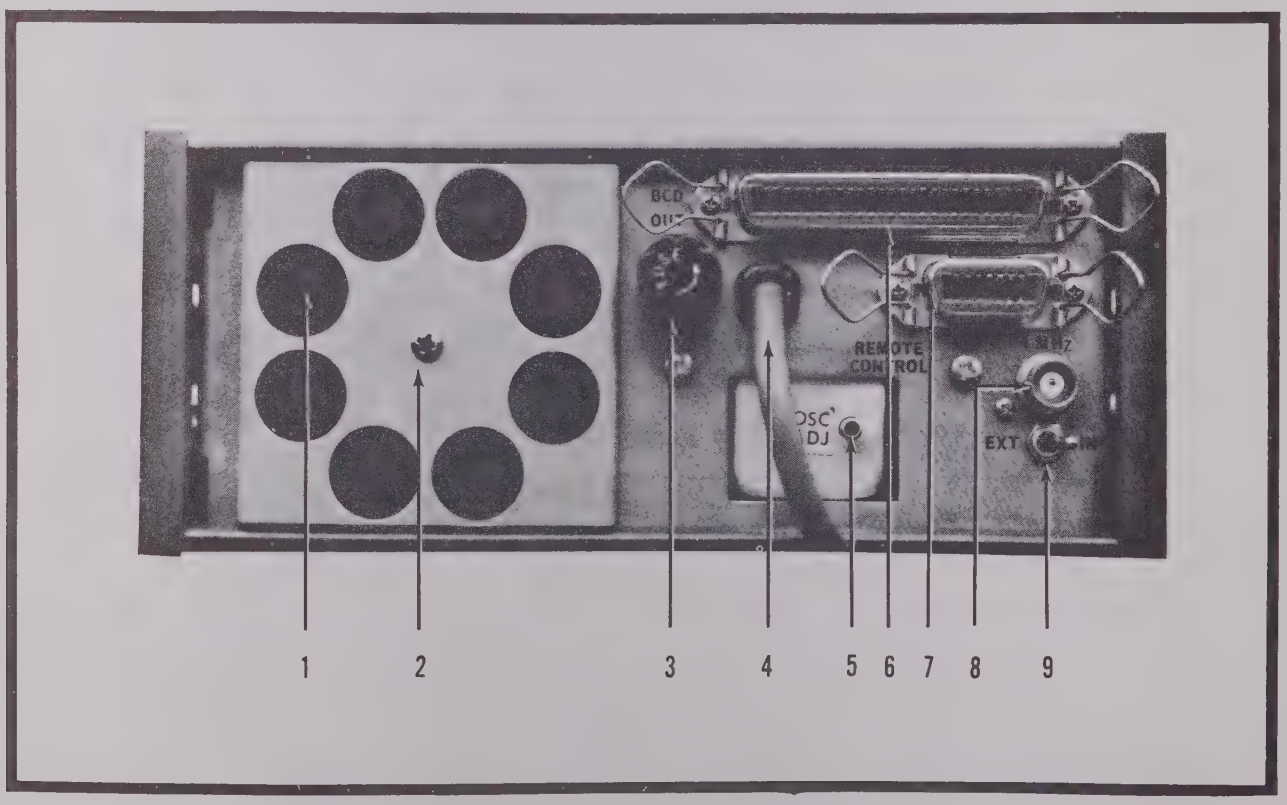


FIGURE 3.2 REAR PANEL, MODEL 6051

TABLE 3.1 FRONT PANEL (Cont'd)

FIGURE INDEX		NAME		FUNCTIONS
3.1	7	kHz (indicator)		Light-emitting diode (LED) when energized, indicates that readout units are in kHz.
3.1	8	MHz (indicator)		Light-emitting diode (LED) when energized, indicates that readout units are in MHz.
3.1	9	O.S. (indicator)		Light-emitting diode (LED) when energized, indicates that a reading is off-scale.
3.1	10	RESOLUTION/Hz (switch)	10^{-1}, 1, 10, 10^{2}, 10^{3}, 10^{4}, 10^{5}, REM.	Switch provides 7 ranges of resolution and a remote position for programmable operation.

TABLE 3.2 REAR PANEL

FIGURE INDEX		NAME		FUNCTIONS
3.2	1	FAN INTAKE		Air intake for cooling.
3.2	2	FAN SCREEN		Screens dust and particulate matter from cooling air (should be cleaned weekly).
3.2	3	FUSE HOLDER		Retains power fuse.
3.2	4	POWER CORD		3-conductor grounded power cord.
3.2	5	1MHz OSCILLATOR (controls)	Coarse Fine	Adjusts the internal 1MHz oscillator frequency.
3.2	6	BCD OUT (optional connector)		Provides BCD information compatible with IC logic.
3.2	7	REMOTE CONTROL (optional connector)		Permits remote operation of attenuator and all front panel controls.

TABLE 3.2 REAR PANEL (Cont'd)

FIGURE	INDEX	NAME	FUNCTION
3.2	8	1MHz (connector)	Provides 1MHz out when INT/EXT switch is in INT position. Provides input for external 1MHz signal when INT/EXT switch is in EXT position.
3.2	9	INT/EXT (switch)	Provides selection of internal or external time base.

3.3 INITIAL TURN-ON AND OPERATIONAL CHECK

The following procedures verify operation of the Model 6051 prior to on-line usage. Successful completion of these checks should precede any performance tests.

1. Connect power cord to 115V ac source.

CAUTION

Be sure transformer is wired for 115V operation (see Section 2.3.1).

2. Position INT/EXT switch (Indes 9, Figure 3.2) to INT.
3. Press POWER pushbutton to ON (Index 1, Figure 3.1).
4. Press TEST pushbutton to ON (Index 2, Figure 3.1).
5. Check instrument readout (Table 3.3) while turning RESOLUTION/Hz switch through the (7) selectable ranges.

TABLE 3.3 CHECK, IN TEST

RESOLUTION/HZ SWITCH POSITION	READOUT INDICATION
0.1	XX000.0000 kHz (O.S.)
1	XX1000.000 kHz
10	XX01000.00 kHz
100	XX001000.0 kHz
1 K	XX0001.000 MHz
10 K	XX00001.00 MHz
100 K	XX000001.0 MHz
REMOTE	Same as above

XX - Additional digits are available, E and EE Options.

3.4 OPERATING PROCEDURES

The following procedures outline the general method for operating the Model 6051 in the two measurement ranges.

3.4.1 General

Operation is fully automatic and requires no special adjustments.

3.4.2 20Hz - 200MHz RANGE

1. Press POWER pushbutton to ON.
2. Press proper attenuator pushbutton in accordance with input level. If input level is unknown, select highest attenuation level (X1k) first; then, proceed to select lower attenuation levels (X100, X10, or X1) to obtain consistent count readings.
3. Apply 20Hz - 200MHz signal to 1MΩ Type BNC connector.
4. Select desired readout resolution.
5. Measurement is automatic.

3.4.3 Turn-off Procedures

1. Press POWER pushbutton to OFF.
2. Disconnect power cord from ac source.

NOTE

Do not disconnect power cord from ac source if B, B3, or B4 Oscillator Option is installed. (Crystal oven must remain energized at all times to ensure high-accuracy readout operation.)

CHAPTER 4
CALIBRATION-MAINTENANCE

4.1 INTRODUCTION

This chapter is devoted to maintaining the factory-new performance of the Model 6051 Counter. A calibration procedure, acceptance test and troubleshooting guide have been included for this purpose.

4.2 FACTORY SERVICE

Whenever the instrument requires service, other than normal calibration, the nearest Systron-Donner representative should be contacted. He can provide field service or arrange factory service when necessary. Address all inquires on operation or application to your nearest sales representative, or to:

Sales Manager-Concord Instrument Division
Systron-Donner Corporation
888 Galindo Street
Concord, California 94520

Be sure to specify the complete model and serial number in all correspondence.

4.3 PART LOCATION

Printed circuit board outline drawings and related parts lists have been included in Chapter 5 to facilitate part identification and location.

4.4 CALIBRATION PROCEDURE

The following test equipment is required for calibration and adjustments:

(1) Oscilloscope	Tektronix	Model 581 A or equiv.
(2) Voltmeter	Systron-Donner	Model 9000 or equiv.
(3) Voltmeter	Simpson	Model 260 or equiv.
(4) 1MHz frequency standard; 1 part in 10^{-10} short term.		
(5) Signal Generator	H.P.	Model 608 E or equiv.
(6) RF Voltmeter	H.P.	Model 411 A or equiv.

4.4.1 Power Supply Adjustments (Schematic C39082)

The following chart indicates the proper supply voltages and their associated adjustment controls. All are located on the Power Supply P.C. Assembly. The SD 9000 DVM is used for these measurements.

TABLE 4.1 POWER SUPPLY ADJUSTMENT

LOCATION	VOLTAGE		TOLERANCE
E20	+15.00	R2 +15 adjust	±.10Vdc
E24	+5.00	R4 +15 adjust	±0.01Vdc
E31	-5.20	R13 -5.2 adjust	±0.01Vdc
E27	-15.00	None (R2 +15 adjust)	±1Vdc
E30	+225	None	+80 ±10Vdc as read with the Simpson 260. Voltage is 225V peak but is half-wave rectified, and unfiltered. This accounts for the low voltage reading.

4.4.2 Oscillator Adjustment

Push on TEST pushbutton. Place 1MHz INT/EXT switch to INTernal. With oscilloscope (1), triggered by the 1MHz (4) frequency standard; monitor the 1MHz IN-OUT BNC for a 2.5V peak-peak (minimum amplitude) 1MHz rectangular wave. Set COARSE frequency adjustment (counter rear panel) to a position which results in most stationary waveform on scope. Set FINE frequency adjustment (optional oscillators) to position which results in most stationary waveform on scope. Place 1MHz INT-EXT switch to EXT. Oscilloscope should no longer display 1MHz signal. Remove calibration equipment.

4.4.3 200MHz Input Amp and Decade Adjustment (Schematic D39095)

1. Push the power switch on and depress the X1 ATTENUATOR button.
2. Apply 200MHz at a level of 10 millivolts. This is measured at the front panel as shown in Figure 4.1.
3. With the Resolution switch in 100kHz position, adjust R47 to obtain a good stable reading. Reduce the input level, and repeat the adjustment to find the optimum setting.
4. Note the input voltage level that is required for a stable reading. Increase this level ten times.
5. Depress the X10 ATTENUATOR button and adjust R50 until the 605 just barely counts correctly. Reduce the input level and then increase it to the original X10 level. The 6051 should again present a stable correct reading. The level required should not exceed 100 millivolts.

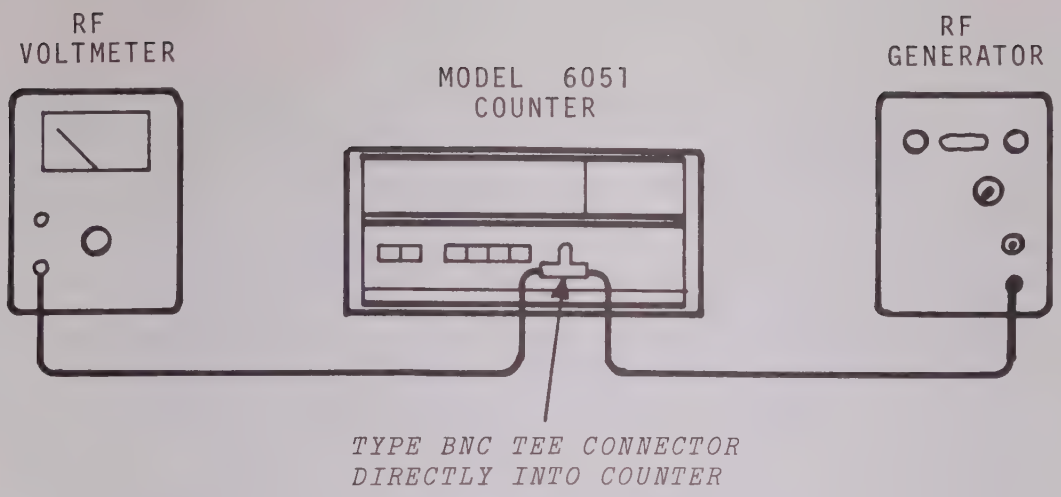


FIGURE 4.1 VOLTAGE MEASUREMENT OF RF INPUT

6. Depress the X100 ATTENUATOR button; then, increase the generator output level another ten times.
7. Adjust C5 so that the 6051 just barely gives a good stable reading. (In later instruments, C5 is not adjustable.)

4.5 BOARD REPAIR

NOTE

READ BEFORE CHANGING ANY COMPONENT ON A PRINTED-CIRCUIT BOARD

When replacing integrated circuits or other electronic components soldered to printed-circuit boards, the procedures indicated below must be followed or damage to the board may result:

1. Determine by troubleshooting techniques, which integrated circuit or discrete component(s) has failed.
2. Remove the defective component(s) from the board by cutting the pins or leads with a small diagonal clipping tool. (Always remove and replace the entire component.)
3. Apply heat (40-50W soldering iron) sparingly to each of the cut pins or leads and remove from the board; clean the hole(s) with a toothpick or solder suction tool.
4. Form the tinned leads of the replacement part and insert in the printed circuit holes; solder, then trim leads to extend 1/16-inch beyond the back surface of the board. (Use only 63-37 solder with maximum 1/16-inch diameter.)

CAUTION

Always trim semiconductor leads only after soldered installation is complete. This procedure greatly lessens the possibility of component failure due to shock-wave damage caused by the trimming tool.

5. When soldering semiconductor devices and all small components, be sure to use a heat sink tool or long-nosed plier connected to the component lead(s) while each is being soldered. Allow the soldered connection to cool before removing the heat sink.

6. Clean all dirt and solder-flux from the printed circuit traces by liberal application of isopropyl alcohol or freon-type solvents.

CHAPTER 5
DRAWINGS AND PARTS LISTS

5.1 INTRODUCTION

This chapter contains the circuit descriptions, drawings, and parts lists for the SD Model 6051 Frequency Counter. Each section is composed of a circuit description, assembly, schematic, and a parts list. All sections are arranged in assembly sequence. Included is the general theory, Block Diagram, and parts list for the entire 6051.

5.2 GENERAL THEORY

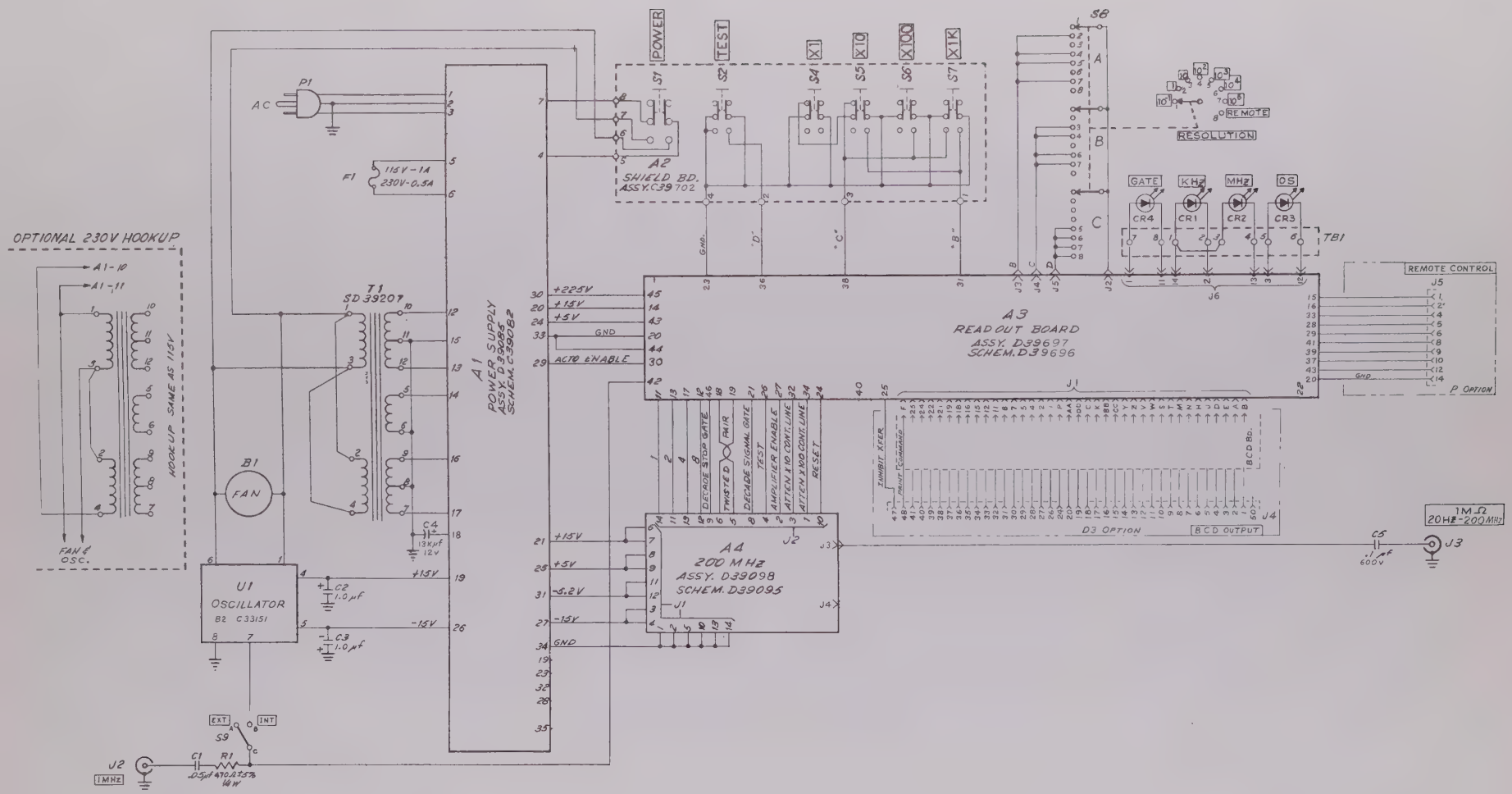
The Model 6051 counter is composed of four basic elements: an input amplifier, a time base ciruit, a function switching circuit, and a counting circuit. Changing the relationship of these basic elements with the FUNCTION switch enables the counter to perform its various modes of operation.

Shaping and amplification of the input signals is accomplished by the input amplifier located on the 200MHz Amp and Decade assembly. The front panel controls for the input signal (ATTENUATOR switch, and the RESOLUTION selector) connect to this amplifier. Output from the amplifier feeds the switching circuits as "count" signals.

The counter time base provides the precise frequencies needed for rate and period measurements. Divider circuits process the output of a crystal oscillator to provide the frequencies required by the counter. The front panel RESOLUTION SELECTOR and FUNCTION switches determine the disposition of these frequencies. Outputs from the time base are sent to the switching circuit as either "count" or "stop/start" signals. The INT/EXT switch and 1MHz IN/OUT jack (rear panel) permit the use of an external oscillator.

The switching circuit regulates the passage of the trigger signal to the counting circuit. There are two elements in the switching circuits: A gate generator that receives "Start/Stop" signals and produces a control gate signal, and an electronic switch that receives a "count" signal and produces the counting circuit trigger. The front panel indication for the condition of the switching circuit is provided by the Gate Lamp which is on when the electronic switch is closed.

The counting circuit is a chain of decades, divide-by-ten elements, with their associated indicators and reset circuitry. In addition to its counting function, this circuit selects automatically the decimal point position and the proper annunciator. The front panel RESET button is also associated with this circuit, as is the rear panel STORAGE switch.



BLOCK DIAGRAM MODEL 6051, D39699A

BLOCK DIAGRAM PARTS LIST

REF.	DESCRIPTION	SD PART NO.
	Block Diagram, Model 6051	D39699A
B1	Blower	H1786
C1	Capacitor, .05μF, 12V	C0672
C2	Capacitor, .01μF, 100V	C0556
C3	Capacitor, .01μF, 100V	C0556
C4	Capacitor, 13KμF, 12V	C1122
C5	Capacitor, .02μF, 600V	C0421
CR1	Assembly Lamp, Light Emitting	CR0367
CR2	Assembly Lamp, Light Emitting	CR0367
CR3	Assembly Lamp, Light Emitting	CR0367
CR4	Assembly Lamp, Light Emitting	CR0367
F1	Fuse, 1A, 3AG	F0001
J1	Not Used	
J2	Connector, BNC	J0165
J3	Connector, BNC	J0260
J4	Connector, 50 Pin	J0170
J5	Connector, 14 Pin	J0310
P1	Line Cord	W0076
R1	Resistor, 470Ω, 1/4W, 5%	R1044
S8	Assembly switch, Resolution	39451
S9	Switch, Toggle, SPDT	S0149
T1	Transformer	39207
U1	Oscillator	33151
	Filter, Polaroid	33922
	Filter, Foam	39410
	Fuse Holder, 3AG	X0034
	Knob	45011360
	Socket, Octal	X0004
	Connector, IC Recept. AMP 60939-1	J0605

CIRCUIT DESCRIPTION
A1 POWER SUPPLY
SCHEMATIC C39082A

The 6050 series Power Supply provides both regulated and unregulated voltages from either a 115V or 230V, 50 to 60Hz source. Primary power arrives at the primary windings of power transformer T1 from the ac line cord, through a line filter, fuse F1, and a POWER/ON switch S1. The power transformer provides three separate secondary windings from which the following voltages are obtained: +225V dc (indicator tubes), +5V dc (logic), and ±15V dc (bias). A special ACTO +5V dc and -5.2V dc are provided with additional circuitry.

+225 Supply (unregulated)

The +225V supply voltage is produced in the following manner: approximatley 175V rms from the T1 secondary winding, 5-6 is half-wave rectified by CR5. The resultant voltage is distributed to the indicator tube circuitry on the Readout Board via Pin E30.

+15V Supply (regulated)

The regulated +15V supply is based on 35V rms from the center-tapped secondary winding, 10-11-12. A full-wave bridge rectifier, CR1-CR4, and filter capacitor C2 produce a +22 volt dc potential which is applied to the integrated circuit regulator, U1. The regulated +15V output is then controlled by the series pass transistor Q1, permitting about 300mA maximum current at Pins E19-E21.

-15V Supply (regulated)

The regulated -15V supply is based on 35V rms from the center-tapped secondary winding, 10-11-12, and referenced to the +15V regulated supply. The -22 volt dc potential, filtered by C3, is fed through R8 and pass transistor Q4 to the differential amplifier Q2 and Q3. This amplifier keeps the junction of R7 and R9 at 0 potential.

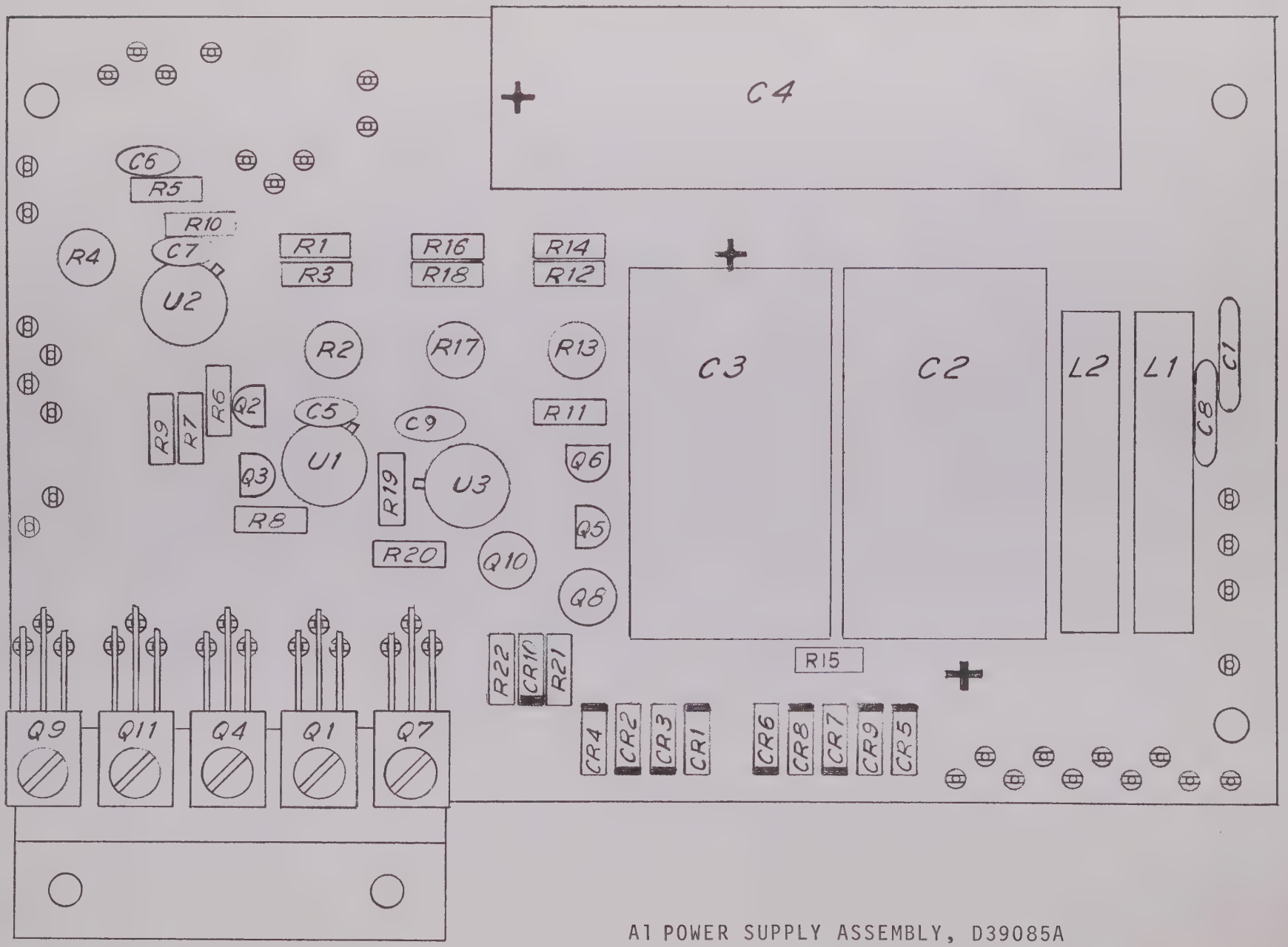
Since R7 and R9 are equal, the voltage drop across each is the same. Thus, if R2 adjusts the +15V supply, the -15 volts across R9 will track. 300mA is available at Pins E26-E28.

+5V Supply (regulated)

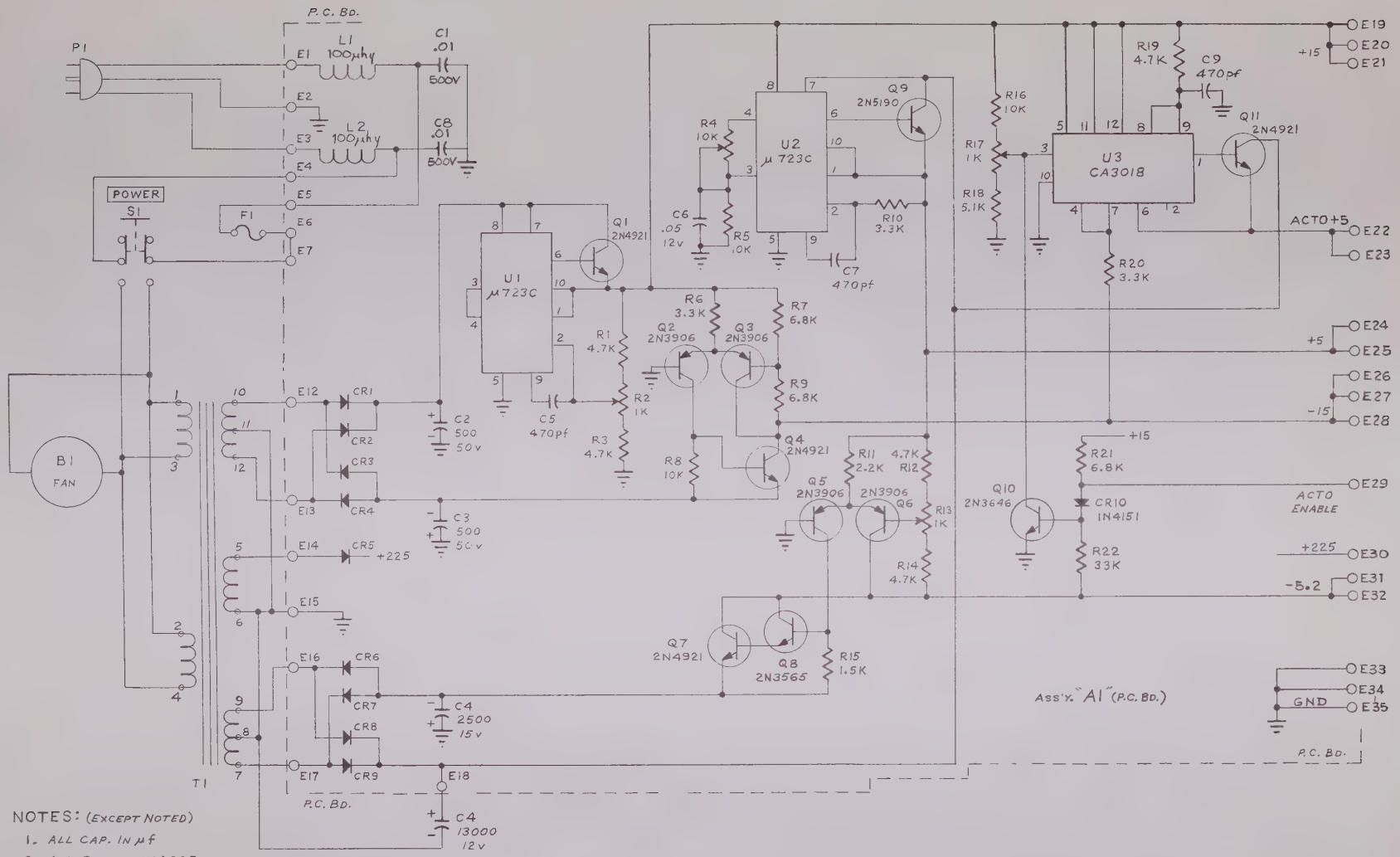
From secondary winding 7-8-9 of T1 and the full-wave bridge, CR6-CR9, a +9V potential is fed to IC regulator U2. The resulting regulated +5V is then passed by Q9, providing about 1.35A of current at E24-E25.

-5.2V Supply (regulated)

From secondary winding 7-8-9 of T1 and the full-wave bridge, a -9V potential is fed to buffer amplifier Q7 and Q8; then, the differential amplifier Q5 and Q6 which references the resulting -5.2V with the regulated +5V supply.



A1 POWER SUPPLY ASSEMBLY, D39085A



NOTES: (EXCEPT NOTED)

1. ALL CAP. IN μf
2. ALL DIODES IN4005
3. ALL RES. ¼W, 5%
4. F1 = 1 AMP. FAST BLO (110V)
   .5 " " " (220V)

	LAST №	NOT USED
CAP.	C9	-
DIODE	CR10	-
INDUCT.	L2	-
I C	U3	-
RES.	R22	-
TERM.	E35	E8,9,10,11
XISTOR	Q11	-

A1POWER SUPPLY SCHEMATIC, C39082A

A1 POWER SUPPLY PARTS LIST

REF	DESCRIPTION	SD PART NO
	A1 Power Supply P.C. Assembly	D39085R2
	A1 Power Supply Schematic	C39082R2
C1	Capacitor, .01µF, 500V	C0423
C2	Capacitor, 500µF, 50V	C1243
C3	Capacitor, 500µF, 50V	C1243
C4	Capacitor, 2500µF, 15V	C1148
C5	Capacitor, 470pF	C0542
C6	Capacitor, .05µF, 12V	C0672
C7	Capacitor, 470pF	C0542
C8	Capacitor, .01µF, 500V	C0423
CR1	Diode, 1N4005	CR0284
CR2	Diode, 1N4005	CR0284
CR3	Diode, 1N4005	CR0284
CR4	Diode, 1N4005	CR0284
CR5	Diode, 1N4005	CR0284
CR6	Diode, 1N4005	CR0284
CR7	Diode, 1N4005	CR0284
CR8	Diode, 1N4005	CR0284
CR9	Diode, 1N4005	CR0284
CR10	Diode, 1N4151	CR0150
L1	Inductor, 100µH, ±20%	L0166
L2	Inductor, 100µH, ±20%	L0166
Q1	Transistor, 2N4921	Q0267
Q2	Transistor, 2N3906	Q0248
Q3	Transistor, 2N3906	Q0248
Q4	Transistor, 2N4921	Q0267
Q5	Transistor, 2N3906	Q0248
Q6	Transistor, 2N3906	Q0248
Q7	Transistor, 2N4921	Q0267
Q8	Transistor, 2N3565	Q0237
Q9	Transistor, 2N5190	Q0281
Q10	Transistor, 2N3646	Q0218
Q11	Transistor, 2N4921	Q0267
R1	Resistor, 4.7K, 1/4W, 5%	R0892
R2	Resistor, VAR., 1K	R2390
R3	Resistor, 4.7K, 1/4W, 5%	R0892
R4	Resistor, VAR., 10K	R2383
R5	Resistor, 10K, 1/4W, 5%	R0766

A1 POWER SUPPLY PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R6	Resistor, 3.3K, 1/4W, 5%	R0742
R7	Resistor, 6.8K, 1/4W, 5%	R0696
R8	Resistor, 10K, 1/4W, 5%	R0766
R9	Resistor, 6.8K, 1/4W, 5%	R0696
R10	Resistor, 3.3K, 1/4W, 5%	R0742
R11	Resistor, 2.2K, 1/4W, 5%	R0794
R12	Resistor, 4.7K, 1/4W, 5%	R0892
R13	Resistor, VAR., 1K	R2390
R14	Resistor, 4.7K, 1/4W, 5%	R0892
R15	Resistor, 1.5K, 1/4W, 5%	R0783
R16	Resistor, 10K, 1/4W, 5%	R0766
R17	Resistor, VAR., 1K	R2390
R18	Resistor, 5.1K, 1/4W, 5%	R0693
R19	Resistor, 4.7K, 1/4W, 5%	R0892
R20	Resistor, 3.3K, 1/4W, 5%	R0742
R21	Resistor, 6.8K, 1/4W, 5%	R0696
R22	Resistor, 33K, 1/4W, 5%	R0780
U1	Integrated Circuit, µ723C	25756
U2	Integrated Circuit, µ723C	25756
U3	Integrated Circuit, CA3018	25720

CIRCUIT DESCRIPTION

A2 SHIELD BOARD

SCHEMATIC D39100R3

This circuit selects the various functions by pushbuttons located on the front panel. Refer to the Interconnect Diagram in Chapter 5.

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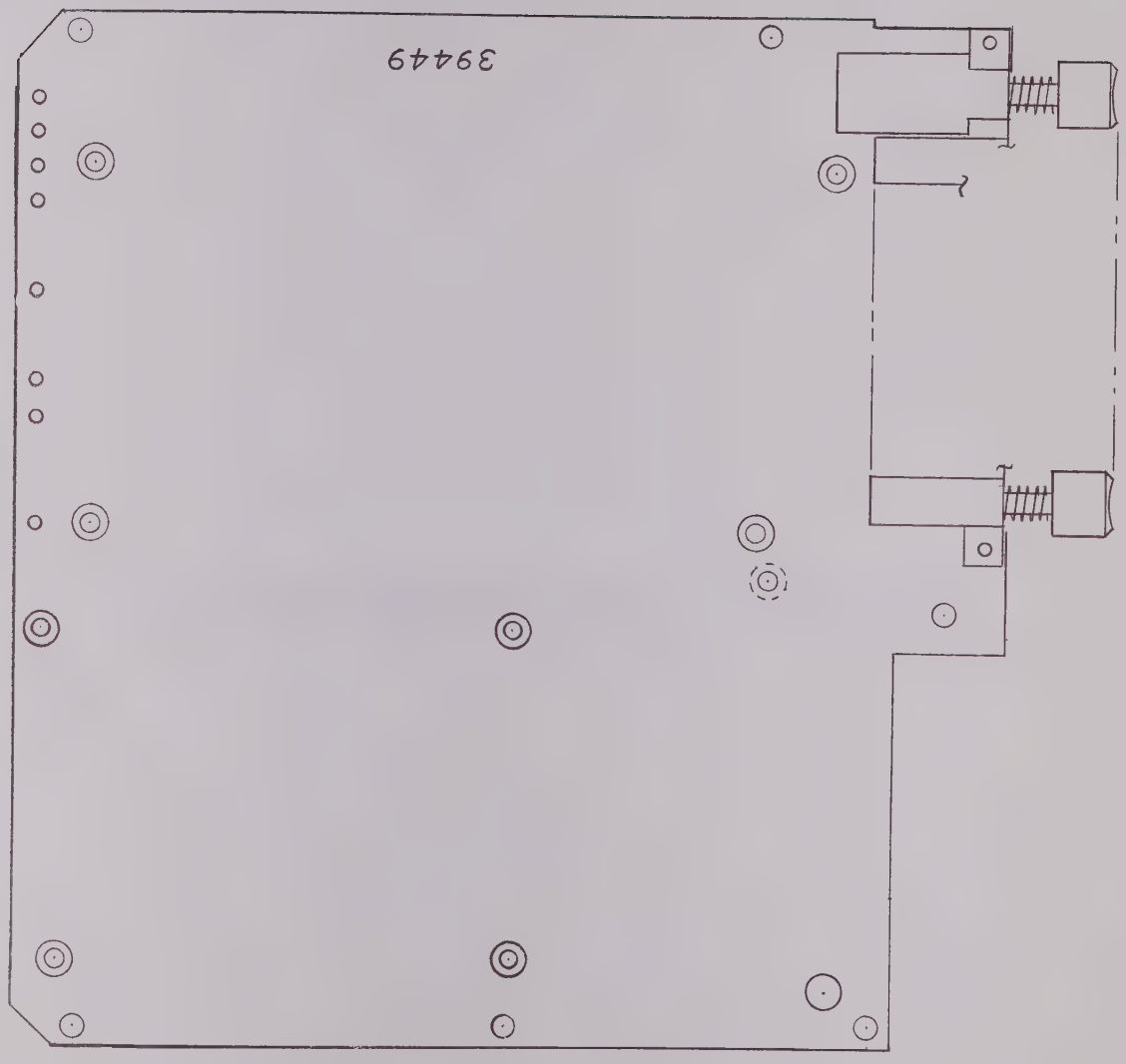


A2, SHIELD BOARD ASSEMBLY, C39448A

A2 SHIELD PARTS LIST

REF.	DESCRIPTION	SD PART NO
	A2 Shield P.C. Assembly	C39448R2
	A2 Shield Schematic	P/O D39100R3
S1	Switch, Pushbutton, 7 STA W/Buttons	S0392
S2	Switch, Pushbutton, 7 STA W/Buttons	S0392
S3	Not Used	
S4	Switch, Pushbutton, 7 STA W/Buttons	S0392
S5	Switch, Pushbutton, 7 STA W/Buttons	S0392
S6	Switch, Pushbutton, 7 STA W/Buttons	S0392
S7	Switch, Pushbutton, 7 STA W/Buttons	S0392

CIRCUIT DESCRIPTION
A3 COUNTER READOUT
SCHEMATIC D33696A

Included on this assembly are:

1. The time base count chain.
2. The resolution and function logic, both for internal and external BCD control.
3. The signal gate control circuitry.
4. The Count Chain.

1. Time Base Count Chain

The internal 1MHz time base is applied to the count chain at terminal E42. This time base is derived from either an internal 6051 crystal-controlled oscillator or from an external standard.

It is first shaped by the Schmitt trigger Q1 and Q2; then, translated to TTL logic levels by Q3. It then drives U2 Pin 14, the first decade in the counting chain. It is followed by U3, U4, U5, U6, U7, and U8, the remainder of the time base decades.

2. Resolution and Function Logic

The outputs of the time base dividers become seven inputs of the two data selectors U1 and U9. Pins 9, 10, and 11 of these data selectors control, by BCD logic, which of the seven input time base frequencies will appear at U1 Pin 5 as the selected time base frequency.

U1 normally selects the time base frequency and is BCD controlled by the 6051 front panel resolution switch. When this switch is turned to the remote position, however, it selects the eighth input, U1 Pin 1 which is connected to the output of U9. U9, in turn, is controlled externally through its BCD inputs which connect to the remote control connector.

The following logic levels appear at the specified pins of the resolution switch giving both internal and remote switch positions.

The logic level at J5 if it is in the 1 state, drives U14 Pins 1, 2 and 4 to the 1 state. Pin 3 of U15 goes to 0 and Pin 6 of U15 goes to a 1 state. Pin 6 of U14 then goes to a 0 state turning Q6 off, extinguishing the MHz lamp and turning Q7 on; thus, supplying current to the kHz lamp.

A 0 at J5 has the opposite effect. By the presence of a 0 at U14 Pin 4, U14 Pin 6 is driven to a 1 state turning Q6 on, supplying current to the MHz lamp, turning Q7 off, extinguishing the MHz lamp.

LOGIC STATES

Internal Pins	E4		E8	E9		
Remote Pins	E37		E39	E41	Decimal Point Position	Binary Number
Remote	0		1	1	-	3
100 kHz	0		0	0	4	0
10 kHz	0	MHz	0	1	5	1
1 kHz	0		1	0	6	2
100 Hz	1		0	0	4	4
10 Hz	1	kHz	0	1	5	5
1 Hz	1		1	0	6	6
0.1 Hz	1		1	1	7	7

Decimal Point

There are three decimal points in the MHz range and four decimal points in the kHz range. As seen from the chart they are positions 4, 5, 6, and 7. They are, with the exception of number 7, the same in the kHz range and in the MHz range. The decimal points are located in the display tubes and are switched by U29, a 4 to 10-line converter. The logic levels at the inputs of U29 are:

Tube	A	B	C	D
4	0	0	1	0
5	1	0	1	0
6	0	0	1	0
7	1	1	1	0

Since the logic levels in the C and D columns do not change they are permanently wired to the 1 and 0 logic levels. The logic levels at A and B are obtained from the terminal lugs, J3, J4 and are inverted by the two gate functions of U10, driving the 4 to 10-line converter U29 which lights the correct decimal point.

When the resolution switch is in the remote position, the decimal point logic is supplied to the external rear panel connector J5 through the other two gating elements of U10.

Function Switch

The front panel function switch is a set of six pushbuttons which supply BCD information to three sections of the quad gate U11. When the resolution switch is in "Remote", the 6051 functions are controlled by BCD from rear panel connector J5, operating the

three sections of the Quad gate U12. The functions and BCD information required at lugs E31, E38, and E36; E33, E28, and E29 respectively are as follows:

FUNCTION BCD

Remote	E33	E28	E29
Front Panel Control	E31	E38	E36
Test	1	0	0
X1	1	1	1
X10	0	1	1
X100	1	0	1
X1k	0	0	1

3. Signal Gate Control

The unijunction transistor Q13 fires developing a positive pulse at base 1. This is amplified and inverted by Q14 and turns Q15 off for the duration of the pulse. The positive pulse at the collector of Q15 resets all the counting decades, the 1Hz and 0.1Hz time base decades, as well as U26, U27, and U23. The positive pulse is inverted by Y25 and then resets U16, U30; it is also available at Pin E24.

U23, a decade counter, is normally driven by 1kHz from U4, a time base divider, through the gate function U17. It will count the 1kHz until the decade reaches the count of nine, at which time it drives the two input Pins 4 and 5 of U22 to the 1 state. Pin 6 of U22 then becomes a 0 disables U17, preventing any more 1kHz pulses from reaching the input of U23. Pin 6 of U22 is inverted by U18. Pin 8 of U18 then becomes an inhibit-start signal for the stop flip-flop U16 by holding the J line, Pin 14, of U16 down in the 0 state. Pin 12 had been set to the 1 state by the negative reset pulse at Pin 6 and Pin 2.

The dual JK flip-flop U16 is initially reset with Pin 12 and Pin 9 in the logical 0 state. (Low voltage state.) The voltage at Pin 13 ($\overline{Q}$) is in the 1 state and is inverted by U17 to cause J (Pin 7) to be in the 0 state preventing Pin 8 (Q) from being driven.

Upon receipt of one of the time base pulses at Pins 1 and 5, Pin 12 is driven to the 1 state which permits the 6051 signal gate to open. At the same time Pin 13 goes to the 0 state and after being inverted by U17, brings Pin 7 (J input) to the 1 state.

The next time base pulse arriving at Pins 1 and 5 cannot drive the left-hand flip-flop because Pin 3 (K) is held in the 0 state and inhibits the flip-flop.

The time base does drive the right hand flip-flop (Pin 5) causing Pin 8 ($\overline{Q}$) to be in the 0 state. Pin 10 (J) is grounded so no

further inputs will be accepted. Pin 8 now inhibits the signal gate and the 6051 count chain no longer has an input.

Transfer Pulse

When the right-hand flip-flop in U16 is driven, Q (Pin 9) is driven to the 1 state. This is inverted by the gate function U11 after which it is differentiated by C4 and R24. It passes through CR2 and turns off Q10. A positive pulse appears at the collector of Q10 which transfers the BCD information contained in the count decades to the SN7475 storage packs.

The stored BCD now contained in the SN7475's is converted to 10 line information and drives the gas display tubes V1 thru V9.

Reset

Pin 8 of U16 is coupled thru R27 to the base of Q12. At the end of the count period Q12 turns off. C5 is then permitted to begin charging to +15V thru R33. When it reaches about +7V the uni-junction transistor Q13 fires, discharging C5 to ground. A positive pulse is developed across R29 and coupled through R30 to the base of Q14. A reset pulse is generated which drives Pin 8 of U16 positive, causing Q12 to turn on and clamp C5 to ground. Now the whole cycle repeats.

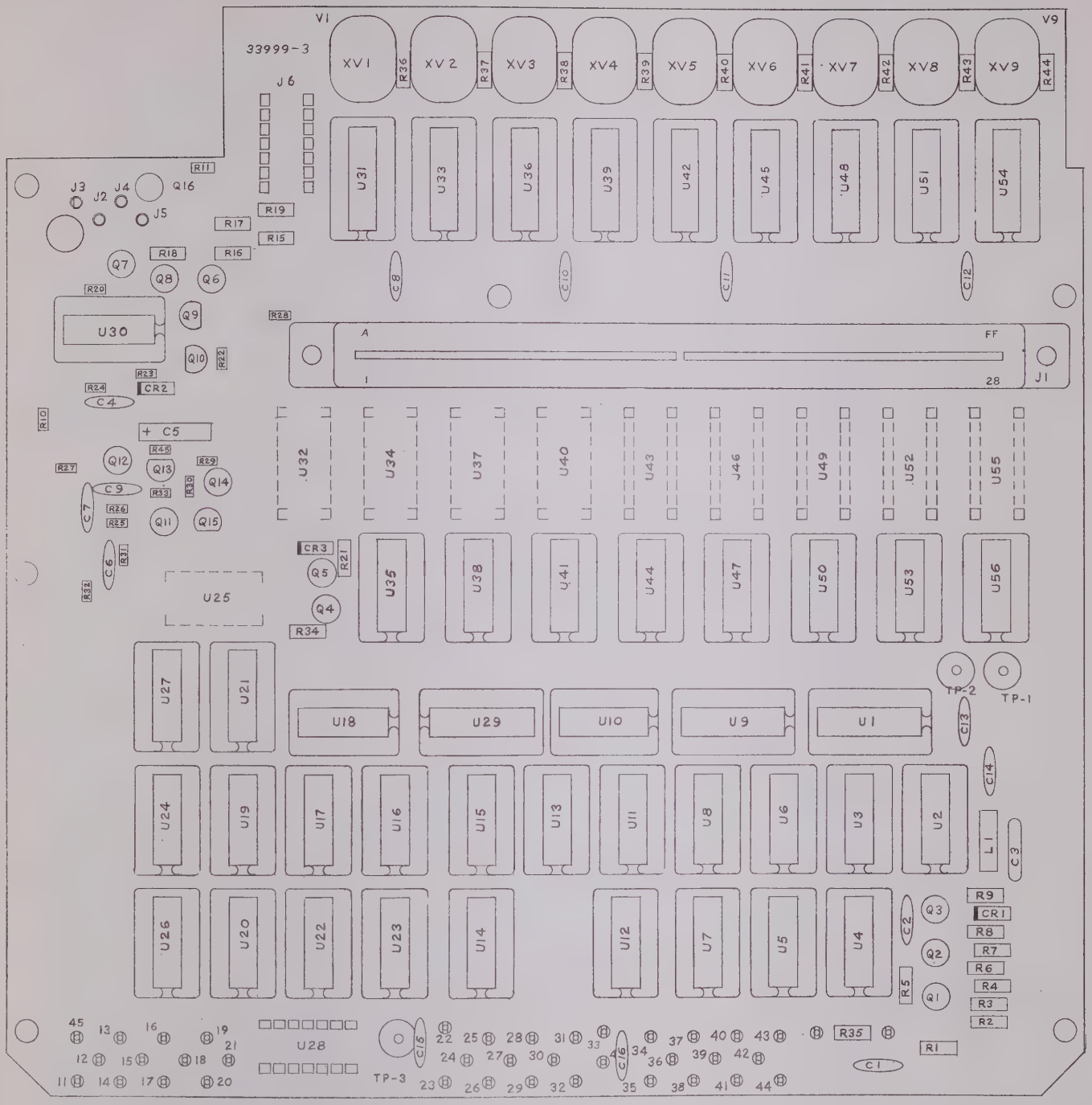
4. Count Chain

The count chain consists of U35, U38, U41, U44, U47, U50, U53, and U56. U35 is a SN7490, the remainder are SN7090 decades. The first decade in the count chain is not on the Readout Board, but instead, is a separate assembly. In the 6051 the first decade is capable of counting up to 200kHz. The input amplifier and signal gating circuits are included on the separate Amp and Decade assembly.

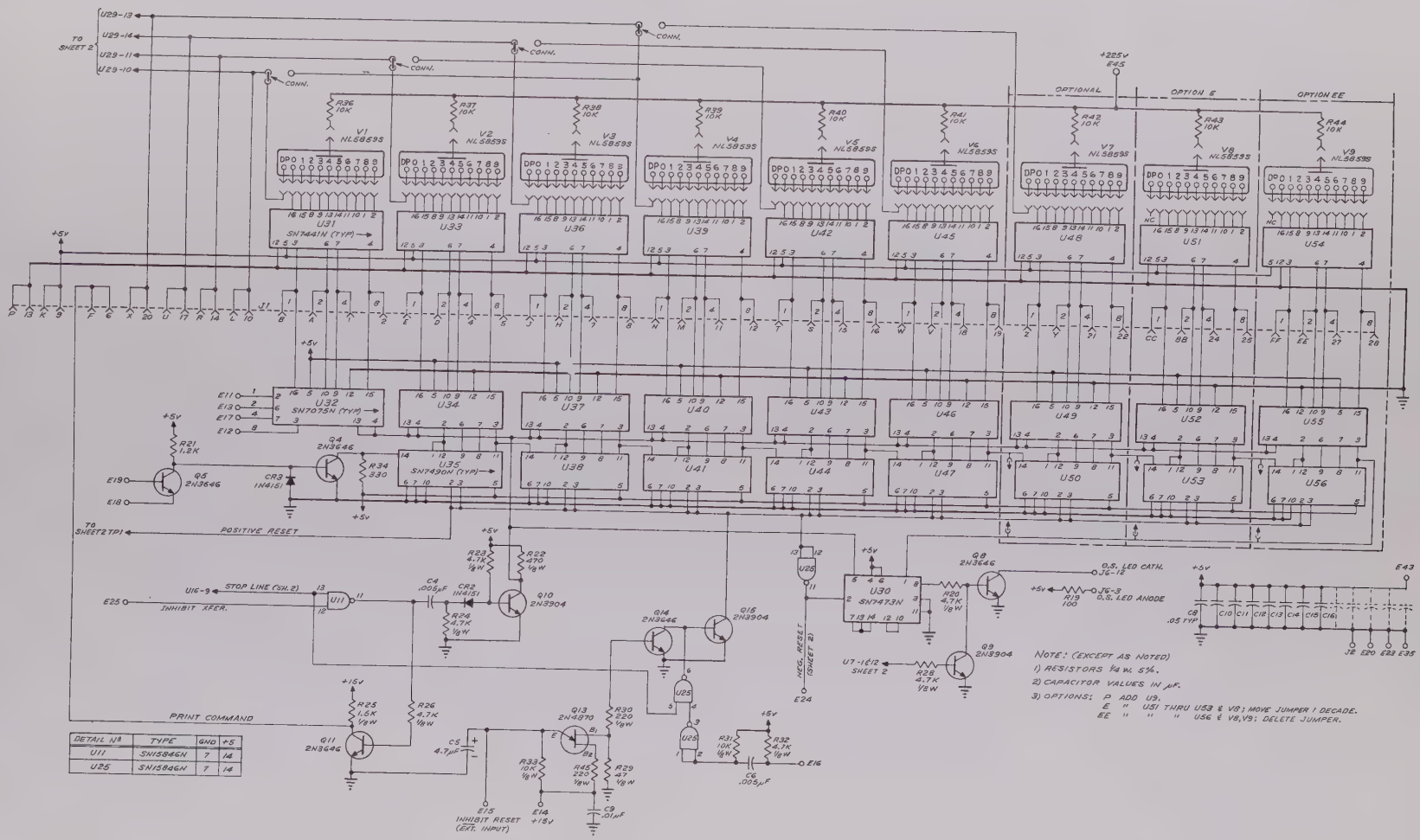
The output of the first decade comes into the Readout Board at E18 and E19. The signal is amplified by Q4 and Q5; then, drives the input (Pin 14) of U35. Pin H of U35 couples to Pin 14 of U38, and so on.

The BCD information enters the Readout Board at lugs E11, E12, E13, and E17 where it is stored in U32. The output of U32, when strobed by the control circuitry on Pins 4 and 13, is translated to 10-line by U31 (SN7441). The output of U31 grounds one of the ten cathodes at the gas display tube V1 causing a number to glow.

The remaining storage packs (SN7475) are U34, U37, U40, U43, U46, U49, U52, and U55, and operate in the same manner.

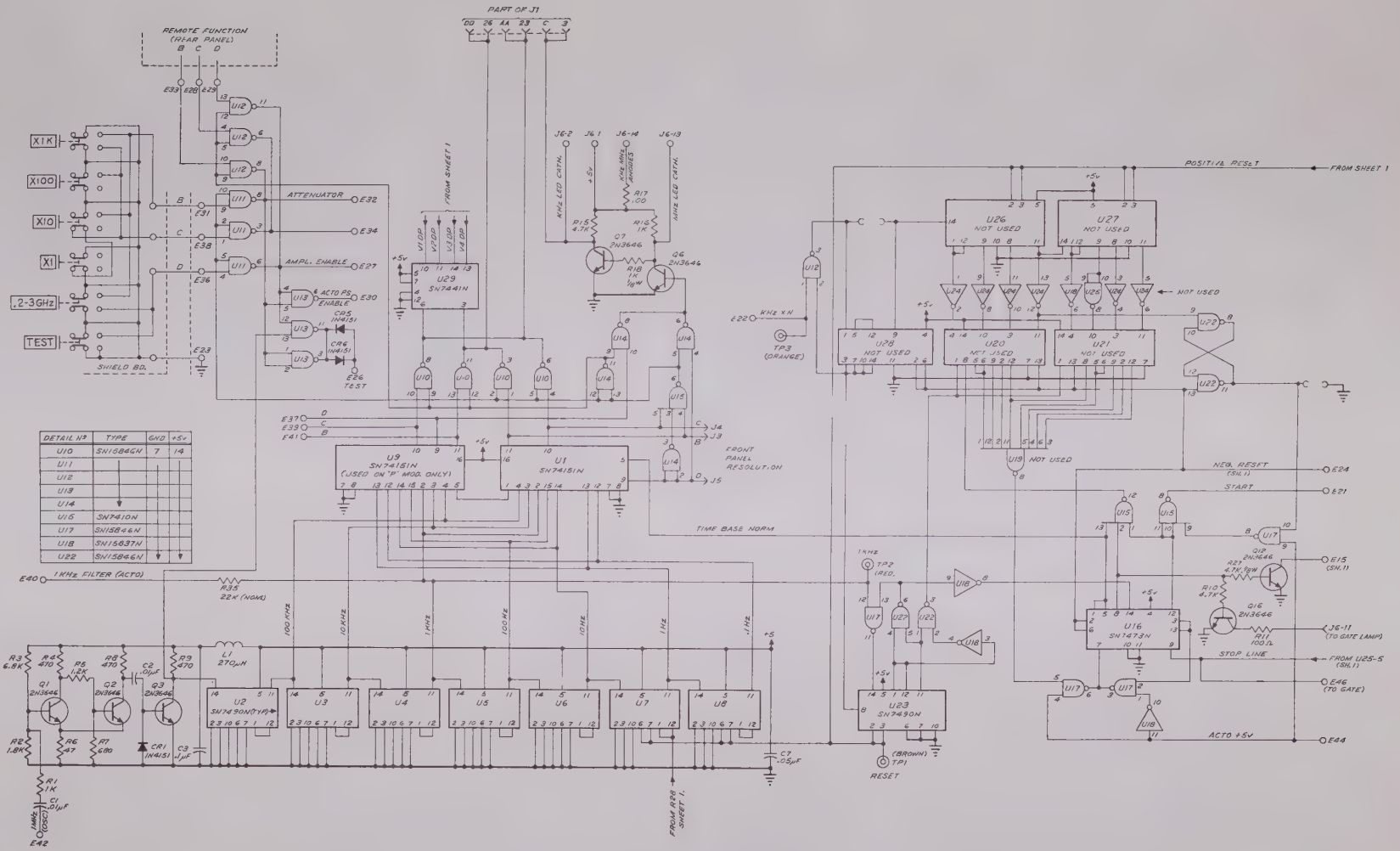


A3 COUNTER READOUT ASSEMBLY, D39697A



DETAIL №	TYPE	GND	+5
U11	SN15846N	7	14
U25	SN15846N	7	14

A3 COUNTER READOUT SCHEMATIC (Sheet 1 of 2), D39696A



DETAIL N°	TYPE	GND	+5V
U10	SN1084GN	7	14
U11			
U12			
U13			
U14			
U15	SN7410N		
U17	SN1584GN		
U18	SN15837N		
U22	SN1584GN		

A3 COUNTER READOUT SCHEMATIC (Sheet 2 of 2), D39696A

A3 COUNTER READOUT PARTS LIST

REF.	DESCRIPTION	SD PART NO.
	A3 Readout Board P.C. Assembly	D39697A
	A3 Readout Board Schematic	D39696A
C1	Capacitor, .01µF, 100V	C0556
C2	Capacitor, .01µF, 100V	C0556
C3	Capacitor, .1µF, 50V	C0881
C4	Capacitor, .005µF, 150V	C0325
C5	Capacitor, 4.7µF	C0406
C6	Capacitor, .005µF, 150V	C0325
C7	Capacitor, .05µF, 12V, Disc	C0672
C8	Capacitor, .05µF, 12V, Disc	C0672
C9	Capacitor, .01µF, 100V	C0556
C10	Capacitor, .05µF, 12V, Disc	C0672
C11	Capacitor, .05µF, 12V, Disc	C0672
C12	Capacitor, .05µF, 12V, Disc	C0672
C13	Capacitor, .05µF, 12V, Disc	C0672
C14	Capacitor, .05µF, 12V, Disc	C0672
C15	Capacitor, .05µF, 12V, Disc	C0672
C16	Capacitor, .05µF, 12V, Disc	C0672
CR1	Diode, 1N4151	CR0150
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
CR4	Not Used	
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
J1	Connector, P.C., 28/56, 2VH28/1AV5	09060800
J2	Connector, Post, AMP 61067-1	E0318
J3	Connector, Post, AMP 61067-1	E0318
J4	Connector, Post, AMP 61067-1	E0318
J5	Connector, Post, AMP 61067-1	E0318
J6	Connector, Socket, I.C., 14 Term	X0186
L1	Inductor, 270µH	L0067
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3646	Q0218
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Transistor, 2N3646	Q0218
Q7	Transistor, 2N3646	Q0218
Q8	Transistor, 2N3646	Q0218
Q9	Transistor, 2N3904	Q0247
Q10	Transistor, 2N3904	Q0247

A3 COUNTER READOUT PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
Q11	Transistor, 2N3646	Q0218
Q12	Transistor, 2N3646	Q0218
Q13	Transistor, 2N4870	Q0266
Q14	Transistor, 2N3646	Q0218
Q15	Transistor, 2N3904	Q0247
Q16	Transistor, 2N3646	Q0218
R1	Resistor, 1K, 1/4W, 5%	R0765
R2	Resistor, 1.8K, 1/4W, 5%	R0959
R3	Resistor, 6.8K, 1/4W, 5%	R0696
R4	Resistor, 470Ω, 1/4W, 5%	R1044
R5	Resistor, 1.2K, 1/4W, 5%	R0809
R6	Resistor, 47Ω, 1/4W, 5%	R0743
R7	Resistor, 680Ω, 1/4W, 5%	R1234
R8	Resistor, 470Ω, 1/4W, 5%	R1044
R9	Resistor, 470Ω, 1/4W, 5%	R1044
R10	Resistor, 4.7K, 1/8W, 5%	R1733
R11	Resistor, 100Ω, 1/4W, 5%	R0966
R12	Not Used	
R13	Not Used	
R14	Not Used	
R15	Resistor, 4.7K, 1/4W, 5%	R0892
R16	Resistor, 1K, 1/4W, 5%	R0765
R17	Resistor, 100Ω, 1/4W, 5%	R0966
R18	Resistor, 1K, 1/4W, 5%	R0765
R19	Resistor, 100Ω, 1/4W, 5%	R0966
R20	Resistor, 4.7K, 1/8W, 5%	R1733
R21	Resistor, 1.2K, 1/4W, 5%	R0809
R22	Resistor, 470Ω, 1/8W, 5%	R1451
R23	Resistor, 4.7K, 1/8W, 5%	R1733
R24	Resistor, 4.7K, 1/8W, 5%	R1733
R25	Resistor, 1.5K, 1/8W, 5%	R2463
R26	Resistor, 4.7K, 1/8W, 5%	R1733
R27	Resistor, 4.7K, 1/8W, 5%	R1733
R28	Resistor, 4.7K, 1/8W, 5%	R1733
R29	Resistor, 47Ω, 1/8W, 5%	R1449
R30	Resistor, 220Ω, 1/8W, 5%	R1743
R31	Resistor, 10K, 1/8W, 5%	R1437
R32	Resistor, 4.7K, 1/8W, 5%	R1733
R33	Resistor, 10K, 1/8W, 5%	R1437
R34	Resistor, 330Ω, 1/4W, 5%	R0662
R35	Resistor, 22K, 1/4W, 5%	R0768

A3 COUNTER READOUT PARTS LIST (Cont'd)

REF	DESCRIPTION	SD PART NO.
R36	Resistor, 10K, 1/4W, 5%	R0766
R37	Resistor, 10K, 1/4W, 5%	R0766
R38	Resistor, 10K, 1/4W, 5%	R0766
R39	Resistor, 10K, 1/4W, 5%	R0766
R40	Resistor, 10K, 1/4W, 5%	R0766
R41	Resistor, 10K, 1/4W, 5%	R0766
R42	Resistor, 10K, 1/4W, 5%	R0766
R43	Resistor, 10K, 1/4W, 5%	R0766
R44	Resistor, 10K, 1/4W, 5%	R0766
R45	Resistor, 220Ω, 1/8W, 5%	R1743
U1	Integrated Circuit, SN74151N	25771
U2	Integrated Circuit, SN7090N	25732
U3	Integrated Circuit, SN7090N	25732
U4	Integrated Circuit, SN7090N	25732
U5	Integrated Circuit, SN7090N	25732
U6	Integrated Circuit, SN7090N	25732
U7	Integrated Circuit, SN7090N	25732
U8	Integrated Circuit, SN7090N	25732
U9	Integrated Circuit, SN74151N	25771
U10	Integrated Circuit, SN15846	19716
U11	Integrated Circuit, SN15846	19716
U12	Integrated Circuit, SN15846	19716
U13	Integrated Circuit, SN15846	19716
U14	Integrated Circuit, SN15846	19716
U15	Integrated Circuit, SN741CN	19706
U16	Integrated Circuit, SN7473N	19709
U17	Integrated Circuit, SN15846	19716
U18	Integrated Circuit, SN15837N	25728
U19	Not Used	
U20	Not Used	
U21	Not Used	
U22	Integrated Circuit, SN15846	19716
U23	Integrated Circuit, SN7090N	25732
U24	Not Used	
U25	Integrated Circuit, SN15846	19716
U26	Not Used	
U27	Not Used	
U28	Not Used	
U29	Integrated Circuit, SN7441N	19707
U30	Integrated Circuit, SN7473N	19709

A3 COUNTER READOUT PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
U31	Integrated Circuit, SN7441N	19707
U32	Integrated Circuit, SN7075N	25731
U33	Integrated Circuit, SN7441N	19707
U34	Integrated Circuit, SN7075N	25731
U35	Integrated Circuit, SN7490N	19711
U36	Integrated Circuit, SN7441N	19707
U37	Integrated Circuit, SN7075N	25731
U38	Integrated Circuit, SN7090N	25732
U39	Integrated Circuit, SN7441N	19707
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U44	Integrated Circuit, SN7090N	25732
U45	Integrated Circuit, SN7441N	19707
U46	Integrated Circuit, SN7075N	25731
U47	Integrated Circuit, SN7090N	25732
U48	Integrated Circuit, SN7441N	19707
U49	Integrated Circuit, SN7075N	25731
U50	Integrated Circuit, SN7090N	25732
U51	Integrated Circuit, SN7441N	19707
U52	Integrated Circuit, SN7075N	25731
U53	Integrated Circuit, SN7090N	25732
U54	Integrated Circuit, SN7441N	19707
U55	Integrated Circuit, SN7075N	25731
U56	Integrated Circuit, SN7090N	25732
V1	Tube, Readout, NL5859S	V0131
V2	Tube, Readout, NL5859S	V0131
V3	Tube, Readout, NL5859S	V0131
V4	Tube, Readout, NL5859S	V0131
V5	Tube, Readout, NL5859S	V0131
V6	Tube, Readout, NL5859S	V0131
V7	Tube, Readout, NL5859S	V0131
V8	Tube, Readout, NL5859S	V0131
V9	Tube, Readout, NL5859S	V0131
XU1	Integrated Circuit Socket, 8 Term	X0185
XU2	Integrated Circuit Socket, 7 Term	X0184
XU3	Integrated Circuit Socket, 7 Term	X0184
XU4	Integrated Circuit Socket, 7 Term	X0184
XU5	Integrated Circuit Socket, 7 Term	X0184

A3 COUNTER READOUT PARTS LIST (Cont'd)

REF	DESCRIPTION	SD PART NO.
XU6	Integrated Circuit Socket, 7 Term	X0184
XU7	Integrated Circuit Socket, 7 Term	X0184
XU8	Integrated Circuit Socket, 7 Term	X0184
XU9	Integrated Circuit Socket, 8 Term	X0185
XU10	Integrated Circuit Socket, 7 Term	X0184
XU11	Integrated Circuit Socket, 7 Term	X0184
XU12	Integrated Circuit Socket, 7 Term	X0184
XU13	Integrated Circuit Socket, 7 Term	X0184
XU14	Integrated Circuit Socket, 7 Term	X0184
XU15	Integrated Circuit Socket, 7 Term	X0184
XU16	Integrated Circuit Socket, 7 Term	X0184
XU17	Integrated Circuit Socket, 7 Term	X0184
XU18	Integrated Circuit Socket, 7 Term	X0184
XU19	Integrated Circuit Socket, 7 Term	X0184
XU20	Integrated Circuit Socket, 7 Term	X0184
XU21	Integrated Circuit Socket, 7 Term	X0184
XU22	Integrated Circuit Socket, 7 Term	X0184
XU23	Integrated Circuit Socket, 7 Term	X0184
XU24	Integrated Circuit Socket, 7 Term	X0184
XU25	Integrated Circuit Socket, 7 Term	X0184
XU26	Integrated Circuit Socket, 7 Term	X0184
XU27	Integrated Circuit Socket, 7 Term	X0184
XU28	Integrated Circuit Socket, 7 Term	X0184
XU29	Integrated Circuit Socket, 8 Term	X0185
XU30	Integrated Circuit Socket, 7 Term	X0184
XU31	Integrated Circuit Socket, 8 Term	X0185
XU32	Integrated Circuit Socket, 8 Term	X0185
XU33	Integrated Circuit Socket, 8 Term	X0185
XU34	Integrated Circuit Socket, 8 Term	X0185
XU35	Integrated Circuit Socket, 7 Term	X0184
XU36	Integrated Circuit Socket, 8 Term	X0185
XU37	Integrated Circuit Socket, 8 Term	X0185
XU38	Integrated Circuit Socket, 7 Term	X0184
XU39	Integrated Circuit Socket, 8 Term	X0185
XU40	Integrated Circuit Socket, 8 Term	X0185
XU41	Integrated Circuit Socket, 7 Term	X0184
XU42	Integrated Circuit Socket, 8 Term	X0185
XU43	Integrated Circuit Socket, 8 Term	X0185
XU44	Integrated Circuit Socket, 7 Term	X0184
XU45	Integrated Circuit Socket, 8 Term	X0185

A3 COUNTER READOUT PARTS LIST (Cont'd)

REF	DESCRIPTION	SD PART NO.
XU46	Integrated Circuit Socket, 8 Term	X0185
XU47	Integrated Circuit Socket, 7 Term	X0184
XU48	Integrated Circuit Socket, 8 Term	X0185
XU49	Integrated Circuit Socket, 8 Term	X0185
XU50	Integrated Circuit Socket, 7 Term	X0184
XU51	Integrated Circuit Socket, 8 Term	X0185
XU52	Integrated Circuit Socket, 8 Term	X0185
XU53	Integrated Circuit Socket, 7 Term	X0184
XU54	Integrated Circuit Socket, 8 Term	X0185
XU55	Integrated Circuit Socket, 8 Term	X0185
XU56	Integrated Circuit Socket, 7 Term	X0184
XV1	Socket, Tube, RTS-44	X0179
XV2	Socket, Tube, RTS-44	X0179
XV3	Socket, Tube, RTS-44	X0179
XV4	Socket Tube, RTS-44	X0179
XV5	Socket, Tube, RTS-44	X0179
XV6	Socket, Tube, RTS-44	X0179
XV7	Socket, Tube, RTS-44	X0179
XV8	Socket, Tube, RTS-44	X0179
XV9	Socket, Tube, RTS-44	X0179

CIRCUIT DESCRIPTION
A4 200MHz AMP AND DECADE
SCHEMATIC D39095A

The 200MHz Amp and Decade circuit description consists of the following sections:

1. X100 Input Attenuator.
2. High input impedance, gain-controlled input stage.
3. Two stages of grounded emitter and two stages of emitter follower amplifier.
4. Schmitt trigger.
5. Signal Gate.
6. 200MHz MECL decade counts with translator to provide TTL BCD logic level output.

The input to the 200MHz Amp and Decade is capacitor-coupled to the input attenuator. This attenuator is controlled by a relay and has an attenuation factor of X1 or X100.

The output of the attenuator is applied to gate 1 of the MOS transistor Q2. This transistor has a voltage gain of 2 or 0.2 and is controlled by the bias on gate 2.

An emitter follower Q3 dc couples this stage to the wide-band amplifier Q5, Q6, Q7, and Q8.

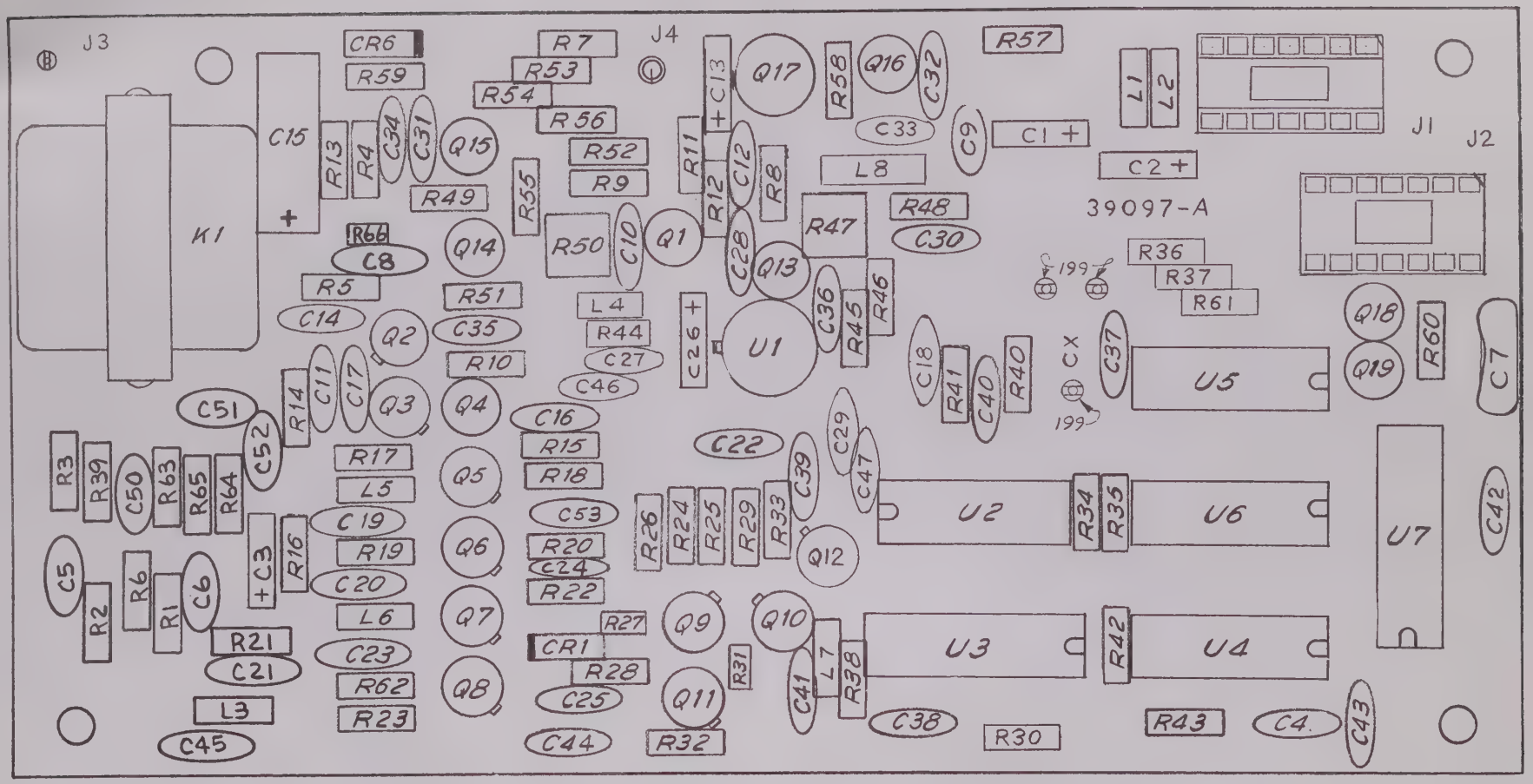
The output of Q8 is applied to the input of the Schmitt trigger, Q9-Q12. The operational amplifier U1, by comparing the dc voltage at the input to the Schmitt trigger, and the voltage at the trigger level potentiometer (R47), adjusts the bias at the base of Q1 to cause the two voltages to become equal.

Two other inputs are provided for the amplifier circuit. One on J2-4 accepts the 1MHz test frequency provided in the 6051. The other, J4 accepts the 20MHz oscillator frequency from the ACTO. When either of these two inputs are used Q2 is turned off by reverse biasing gate 2, thus disabling the normal input.

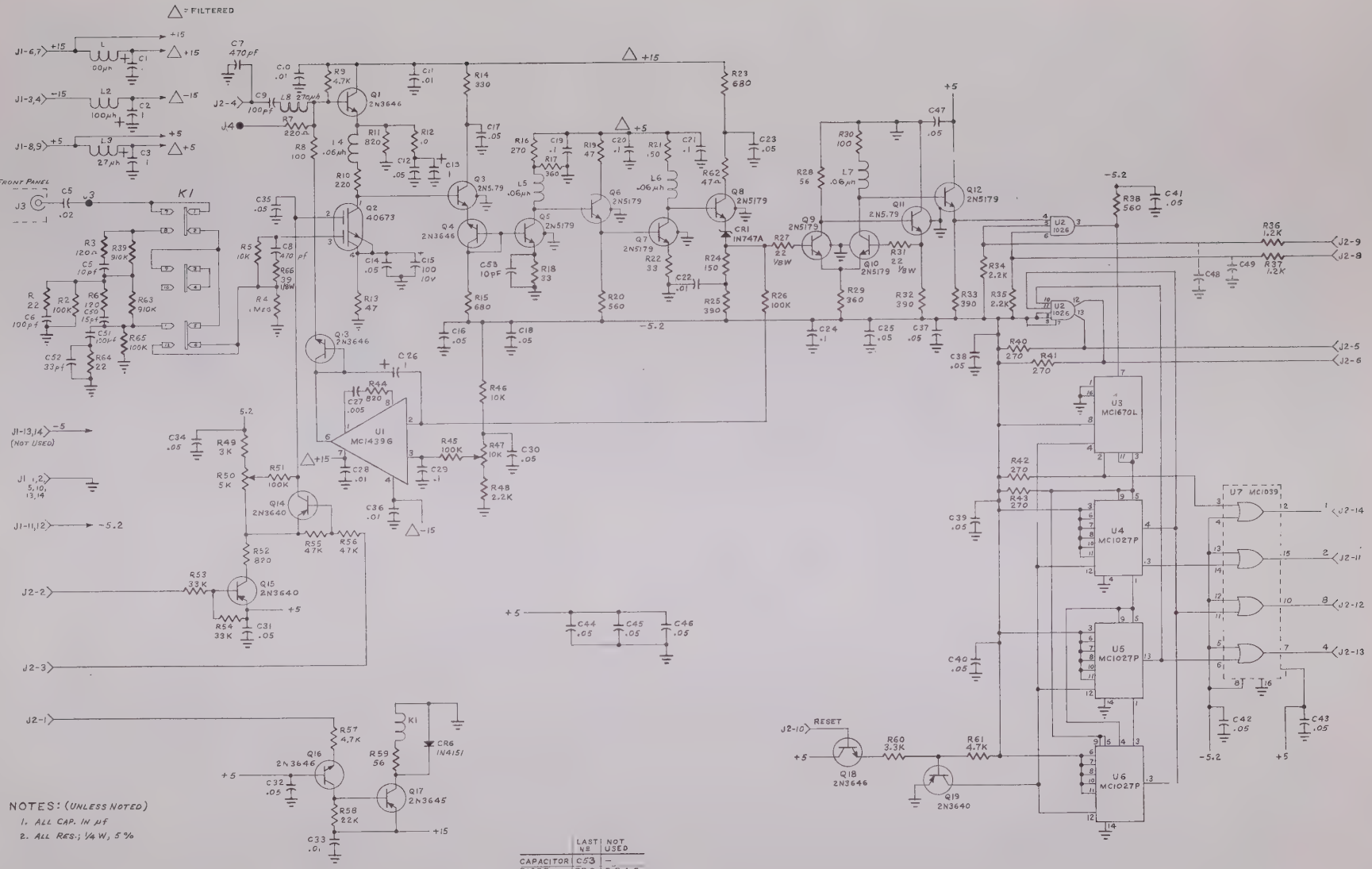
The Schmitt trigger Q9, Q10, Q11, and Q12 is a conventional high-speed circuit. The input is applied to the base of transistor Q9 which drives emitter follower Q11; then, transistor Q10. The output from Q10 is coupled to the signal gate U2 Pin 4 by emitter follower Q12.

The signal gate is turned on and off by applying a voltage at J2-9 and J2-8. A positive (+5V) disables the gate and a ground at these points.

The decade consists of four MECL flip-flops U3, U4, U5, and U6. The output of the decade is buffered by the second half of U2 and goes out on J2-5 and J2-6. The MECL BCD logic levels are translated to TTL logic levels by the translator U7.



A4 200MHz AMP AND DECADE ASSEMBLY, D39098A



	LAST NB	NOT USED
CAPACITOR	C53	–
DIODE	CR6	2,3,4,5
IC	U7	–
INDUCTOR	L8	–
RELAY	K1	–
RESISTOR	R66	–
TRANSISTOR	Q19	–
CONNECTOR	J4	–

A4 200MHz AMP AND DECADE SCHEMATIC, D39095A

A4 200MHz AMP & DECADE PARTS LIST

REF.	DESCRIPTION	SD PART NO.
	200MHz Amp & Decade P.C. Assembly	D39098A
	200MHz Amp & Decade Schematic	D39095A
C1	Capacitor, 1µF, 35V, Tant	C0524
C2	Capacitor, 1µF, 35V, Tant	C0524
C3	Capacitor, 1µF, 35V, Tant	C0524
C4	Capacitor, .01µF, 100V, Disc	C0556
C5	Capacitor, 10pF, DM10	C1193
C6	Capacitor, 100pF, DM10	C1156
C7	Capacitor, 470pF, 300V, DM	C0542
C8	Capacitor, 470pF, 300V, DM	C0542
C9	Capacitor, 100pF, DM10	C1156
C10	Capacitor, .01µF, 100V, Disc	C0556
C11	Capacitor, .01µF, 100V, Disc	C0556
C12	Capacitor, .05µF, 12V, Disc	C0672
C13	Capacitor, 1µF, 35V, Tant	C0524
C14	Capacitor, .05µF, 12V, Disc	C0672
C15	Capacitor, 100µF, 10V, Disc	C0660
C16	Capacitor, .05µF, 12V, Disc	C0672
C17	Capacitor, .05µF, 12V, Disc	C0672
C18	Capacitor, .05µF, 12V, Disc	C0672
C19	Capacitor, .1µF, 10V, Disc	C0661
C20	Capacitor, .1µF, 10V, Disc	C0661
C21	Capacitor, .1µF, 10V, Disc	C0661
C22	Capacitor, .01µF, 100V, Disc	C0556
C23	Capacitor, .05µF, 12V, Disc	C0672
C24	Capacitor, .1µF, 10V, Disc	C0661
C25	Capacitor, .05µF, 12V, Disc	C0672
C26	Capacitor, 1µF, 35V, Tant	C0524
C27	Capacitor, .005µF, 150V, Disc	C0325
C28	Capacitor, .01µF, 100V, Disc	C0556
C29	Capacitor, 1µF, 10V, Disc	C0661
C30	Capacitor, .05µF, 12V, Disc	C0672
C31	Capacitor, .05µF, 12V, Disc	C0672
C32	Capacitor, .05µF, 12V, Disc	C0672
C33	Capacitor, .01µF, 100V, Disc	C0556
C34	Capacitor, .05µF, 12V, Disc	C0672
C35	Capacitor, .05µF, 12V, Disc	C0672
C36	Capacitor, .01µF, 100V, Disc	C0556
C37	Capacitor, .05µF, 12V, Disc	C0672
C38	Capacitor, .05µF, 12V, Disc	C0672

A4 200MHz AMP & DECADE PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
C39	Capacitor, .05µF, 12V, Disc	C0672
C40	Capacitor, .05µF, 12V, Disc	C0672
C41	Capacitor, .05µF, 12V, Disc	C0672
C42	Capacitor, .05µF, 12V, Disc	C0672
C43	Capacitor, .05µF, 12V, Disc	C0672
C44	Capacitor, .05µF, 12V, Disc	C0672
C45	Capacitor, .05µF, 12V, Disc	C0672
C46	Capacitor, .05µF, 12V, Disc	C0672
C47	Capacitor, .05µF, 12V, Disc	C0672
C48	Capacitor, Selected	Cxxxx
C49	Capacitor, Selected	Cxxxx
C50	Capacitor, 15pF, 500V, DM10	C1267
C51	Capacitor, 100pF, DM10	C1156
C52	Capacitor, 33pF, 500V, DM10	C1268
C53	Capacitor, 10pF, DM10	C1193
CR1	Diode, 1N747A	CR5005
CR2	Not Used	
CR3	Not Used	
CR4	Not Used	
CR5	Not Used	
CR6	Diode, 1N4151	CR0150
J1	Integrated Circuit Socket, 14 Pin	X0106
J2	Integrated Circuit Socket, 14 Pin	X0186
J3	Not Used	
J4	Connector, Post, AMP 61067-1	E0318
K1	Relay, Printact #12BP3G	K0135
L1	Inductor, 100µH	L0073
L2	Inductor, 100µH	L0073
L3	Inductor, 27µH	L0076
L4	Inductor, .06µH	L0158
L5	Inductor, .06µH	L0158
L6	Inductor, .06µH	L0158
L7	Inductor, .06µH	L0158
L8	Inductor, 270µH, Wee	L0167
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 40673	Q0297
Q3	Transistor, 2N5179	Q0269
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N5179	Q0269

A4 200MHz AMP & DECADE PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
Q6	Transistor, 2N5179	Q0269
Q7	Transistor, 2N5179	Q0269
Q8	Transistor, 2N5179	Q0269
Q9	Transistor, 2N5179	Q0269
Q10	Transistor, 2N5179	Q0269
Q11	Transistor, 2N5179	Q0269
Q12	Transistor, 2N5179	Q0269
Q13	Transistor, 2N3646	Q0218
Q14	Transistor, 2N3640	Q0178
Q15	Transistor, 2N3640	Q0178
Q16	Transistor, 2N3646	Q0218
Q17	Transistor, 2N3645	Q0215
Q18	Transistor, 2N3646	Q0218
Q19	Transistor, 2N3640	Q0178
R1	Resistor, 22Ω, 1/4W, 5%	R1436
R2	Resistor, 100K, 1/4W, 5%	R0741
R3	Resistor, 120Ω, 1/4W, 5%	R1461
R4	Resistor, 1MΩ, 1/4W, 5%	R0692
R5	Resistor, 10K, 1/4W, 5%	R0766
R6	Resistor, 120Ω, 1/4W, 5%	R1461
R7	Resistor, 220Ω, 1/4W, 5%	R0760
R8	Resistor, 100Ω, 1/4W, 5%	R0966
R9	Resistor, 4.7K, 1/4W, 5%	R0892
R10	Resistor, 220Ω, 1/4W, 5%	R0760
R11	Resistor, 820Ω, 1/4W, 5%	R0762
R12	Resistor, 10Ω, 1/4W, 5%	R0739
R13	Resistor, .47Ω, 1/4W, 5%	R0743
R14	Resistor, 330Ω, 1/4W, 5%	R0662
R15	Resistor, 680Ω, 1/4W, 5%	R1234
R16	Resistor, 270Ω, 1/4W, 5%	R0694
R17	Resistor, 360Ω, 1/4W, 5%	R1571
R18	Resistor, 33Ω, 1/4W, 5%	R1550
R19	Resistor, 47Ω, 1/4W, 5%	R0743
R20	Resistor, 560Ω, 1/4W, 5%	R0819
R21	Resistor, 150Ω, 1/4W, 5%	R0983
R22	Resistor, 33Ω, 1/4W, 5%	R1550
R23	Resistor, 680Ω, 1/4W, 5%	R1234
R24	Resistor, 150Ω, 1/4W, 5%	R0983
R25	Resistor, 390Ω, 1/4W, 5%	R0880

A4 200MHz AMP & DECADE PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
R26	Resistor, 100K, 1/4W, 5%	R0741
R27	Resistor, 22Ω, 1/8W, 5%	R1448
R28	Resistor, 56Ω, 1/4W, 5%	R1554
R29	Resistor, 360Ω, 1/4W, 5%	R1571
R30	Resistor, 100Ω, 1/4W, 5%	R0966
R31	Resistor, 22Ω, 1/8W, 5%	R1448
R32	Resistor, 390Ω, 1/4W, 5%	R0880
R33	Resistor, 390Ω, 1/4W, 5%	R0880
R34	Resistor, 2.2K, 1/4W, 5%	R0794
R35	Resistor, 2.2K, 1/4W, 5%	R0794
R36	Resistor, 1.2K, 1/4W, 5%	R0809
R37	Resistor, 1.2K, 1/4W, 5%	R0809
R38	Resistor, 560Ω, 1/4W, 5%	R0819
R39	Resistor, 910K, 1/4W, 5%	R2312
R40	Resistor, 270Ω, 1/4W, 5%	R0694
R41	Resistor, 270Ω, 1/4W, 5%	R0694
R42	Resistor, 270Ω, 1/4W, 5%	R0694
R43	Resistor, 270Ω, 1/4W, 5%	R0694
R44	Resistor, 820Ω, 1/4W, 5%	R0762
R45	Resistor, 100K, 1/4W, 5%	R0741
R46	Resistor, 10K, 1/4W, 5%	R0766
R47	Resistor, 10K, Potentiometer, CTS 340	R2383
R48	Resistor, 2.2K, 1/4W, 5%	R0794
R49	Resistor, 3K, 1/4W, 5%	R0711
R50	Resistor, 10K, Potentiometer, CTS 340	R2383
R51	Resistor, 100K, 1/4W, 5%	R0741
R52	Resistor, 820Ω, 1/4W, 5%	R0762
R53	Resistor, 33K, 1/4W, 5%	R0780
R54	Resistor, 33K, 1/4W, 5%	R0780
R55	Resistor, 47K, 1/4W, 5%	R0777
R56	Resistor, 47K, 1/4W, 5%	R0777
R57	Resistor, 4.7K, 1/4W, 5%	R0892
R58	Resistor, 22K, 1/4W, 5%	R0768
R59	Resistor, 56Ω, 1/4W, 5%	R1554
R60	Resistor, 3.3K, 1/4W, 5%	R0742
R61	Resistor, 4.7K, 1/4W, 5%	R0892
R62	Resistor, 47Ω, 1/4W, 5%	R0743
R63	Resistor, 910K, 1/4W, 5%	R2312
R64	Resistor, 22Ω, 1/4W, 5%	R1436
R65	Resistor, 100K, 1/4W, 5%	R0741
R66	Resistor, 39Ω, 1/8W, 5%	R1829

A4 200MHz AMP & DECADE PARTS LIST (Cont'd)

REF.	DESCRIPTION	SD PART NO.
U1	Integrated Circuit, MC1439G	25729
U2	Integrated Circuit, MC1026	25780
U3	Integrated Circuit, MC1670L	25765
U4	Integrated Circuit, MC1027P	25719
U5	Integrated Circuit, MC1027P	25719
U6	Integrated Circuit, MC1027P	25719
U7	Integrated Circuit, MC1039	25774
XQ1	Not Used	
XQ2	Transistor Pad	H1838
XQ3	Transistor Pad	H1838
XQ4	Not Used	
XQ5	Transistor Pad	H1838
XQ6	Transistor Pad	H1838
XQ7	Transistor Pad	H1838
XQ8	Transistor Pad	H1838
XQ9	Transistor Pad	H1838
XQ10	Transistor Pad	H1838
XQ11	Transistor Pad	H1838
XQ12	Transistor Pad	H1838
XQ13	Not Used	
XQ14	Not Used	
XQ15	Not Used	
XQ16	Not Used	
XQ17	Transistor Pad	H0515

CHAPTER 6
STANDARD OPTIONS

6.1 INTRODUCTION

The Standard Options available for the SD Model 6051 Frequency Counter are described in the following sections. These are extra cost items to tailor your unit for a specific application. Non-standard Options may be requested and will be described in this chapter when applicable.

OPTION 10
OSCILLATOR (B1)

The B1 Option provides this instrument with a medium stability oscillator.

The B1 Oscillator specifications are as follows:

AGING RATE: ±7 parts in 10^9/24 hrs. // ±2 parts in 10^8/24 hours.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 30 days // 72 hours.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: ±5 parts in 10^9 rms.

LONG-TERM AGING RATE: ±3 parts in 10^9/24 hours after 45 day dynamic.

VARIATION WITH TEMPERATURE: ±5 parts in 10^9/C° from -20° to +50°C.

10% CHANGE IN LINE VOLTAGE: <±2 parts in 10^9.

Parts List

Ref.	Description	SD Part No.
U1	Oscillator, Heated B1	Y0023

OPTION 11
OSCILLATOR (B3)

The B3 Option provides the instrument with a medium stability oscillator. The B3 Oscillator, unlike the standard 1 MHz oscillator, has an output frequency of 3 MHz. A divide-by-three circuit has been added to convert the oscillator's output frequency to the required 1 MHz reference.

The B3 Option comprises the B3 Oscillator, a separate power supply, and a divide-by-three circuit (refer to the Oscillator Power Supply). The improved specifications are listed below:

AGING RATE: ±3 parts in 10^9/24 hrs.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 72 hrs.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: ±1 part in 10^{10} rms.

LONG-TERM AGING RATE: ±3 parts in 10^8/30 days.

VARIATION WITH TEMPERATURE (AVERAGE ±2 PARTS IN 10^{10}/°C):
4 parts in 10 over 20° change within -20°C to +55°C.

±10% CHANGE IN LINE VOLTAGE: ±5 parts in 10^{10}.

Parts List

Ref.	Description	SD Part No.
A7	Oscillator Power P.C. Assembly	B39487
C9	Capacitor, 500 µF, 50 V	C1243
T2	Transformer	19805
U1	Oscillator, B3	C33428

OPTION 12
OSCILLATOR (B)

The B Option provides the insrtument with a high stability oscillator. The B Oscillator, unlike the standard 1 MHz Oscillator, has an output frequency of 3 MHz. A divide-by-three circuit has been added to convert the oscillator's output frequency to the required 1 MHz reference frequency.

The B Option comprises the B Oscillator, a separate power supply, and a divide-by-three circuit (refer to the Oscillator Power Supply). The improved specifications are listed below:

AGING RATE: 1 part in 10^9/24 hrs.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 72 hrs.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: 1 part in 10^{10} rms.

LONG-TERM AGING RATE: ±3 parts in 10^8/30 days.

VARIATION WITH TEMPERATURE (AVERAGE 2 PARTS IN 10^{10}/°C): ±4 parts in 10^9 over 20° change within -20° to +50°C.

10% CHANGE IN LINE VOLTAGE: ±5 parts in 10^{10}.

Parts List

Ref.	Description	SD Part No.
A7	Oscillator Power P.C. Assembly	B39487
C9	Capacitor, 500 µF, 50 V	C1243
T2	Transformer	19805
U1	Oscillator, B	C33427
	Bracket, MT'g., Osc.	B39044
	Wire List	A39551

OPTION 13
OSCILLATOR (B4)

The B4 Option provides the instrument with a very high stability oscillator. Specifications for this oscillator are the following:

FREQUENCY OUTPUT: 1 MHz.

STABILITY:

Temperature -- Less than 5 parts in 10^{11}/C° from 0 to +15°C.

Aging Rate -- Less than 5 parts in 10^{10}/24 hours after warm-up. Up to 72 hrs. may be required to reach this aging rate after lengthy "off" periods of time.

Line Voltage -- Less than ±1 part in 10^{10} for a 10% voltage change.

Short Term -- Less than 5 parts in 10^{11} rms with measurement averaging time of one second under constant enviromental and line voltage conditions.

Frequency Retrace -- After up to 24 hours of shundown, one hour is required to reach within 5 parts in 10^{9} of the frequency that existed at the time of turn off.

FREQUENCY ADJUST:

Range (Coarse) -- ±2 parts in 10^{6}.

Range (fine) -- ±7 parts in 10^{8}.

Resolution -- ±1 part in 10^{10}.

Parts List

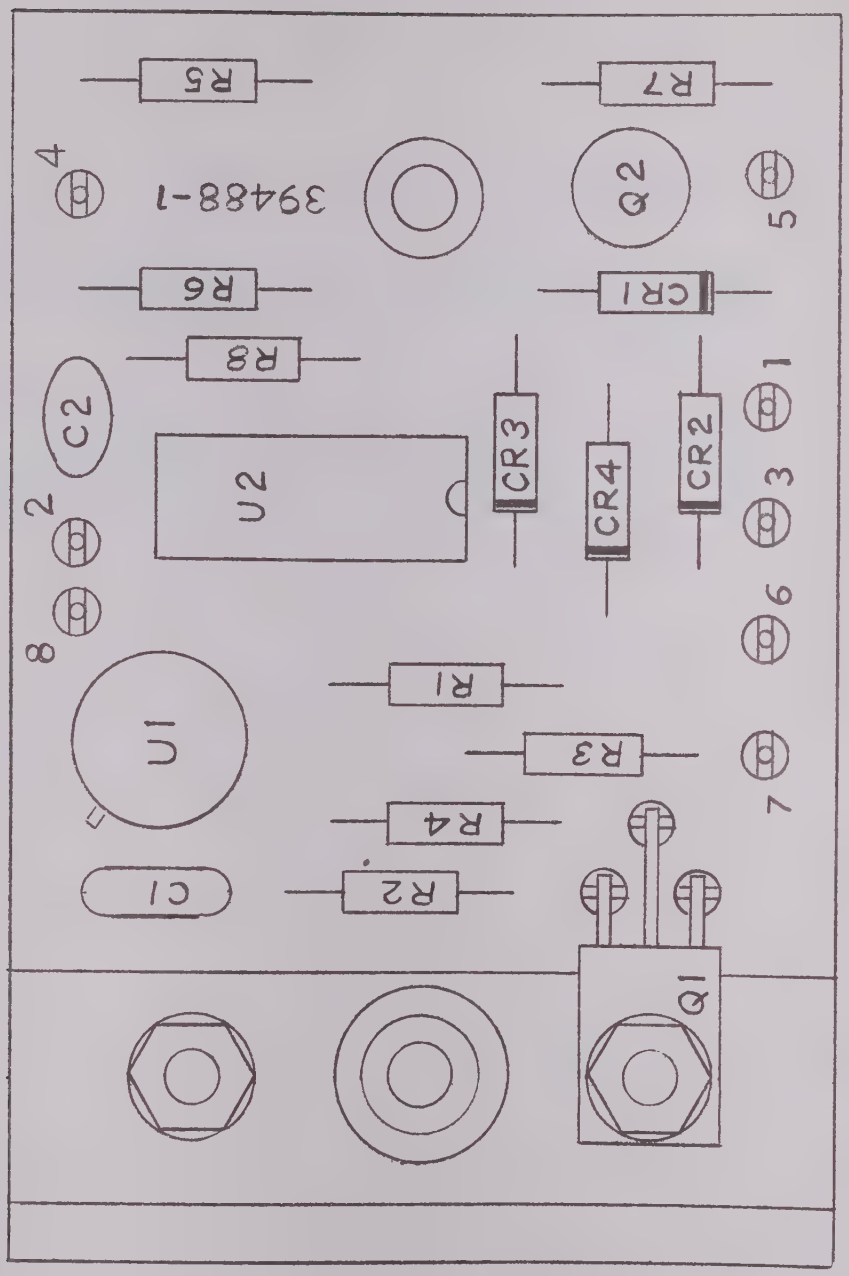
Ref.	Description	SD Part No.
A7	Oscillator Power P.C. Assembly	B39487
C9	Capacitor, 500 µF, 50 V	C1243
T1	Transformer	19805
U1	Oscillator, B4	C33429
	Wire List	A39551

CIRCUIT DESCRIPTION
A7 OSCILLATOR, POWER SUPPLY
SCHEMATIC #B3949OR1
(used with OPTIONS 11, 12, 13)

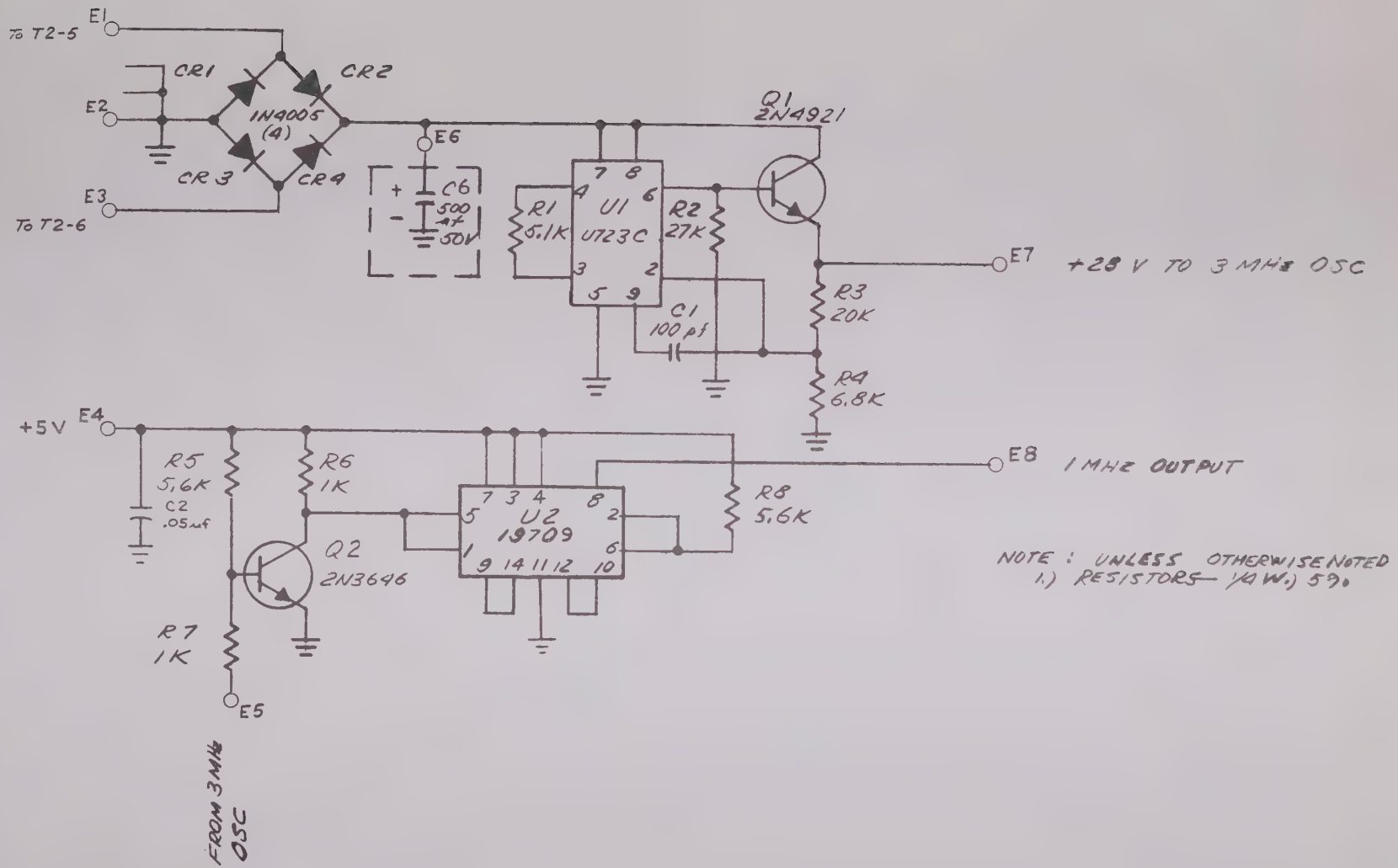
This board contains two circuits: a regulated +28 V dc power supply and a divide-by-3 circuit.

The Oscillator Power Supply consists of a full wave bridge CR1, 2, 3, 4 which supplies 28 Volts dc to regulator U1 and series pass transistor Q1. The necessary regulated 28 Volts is then fed to the oscillator.

The divide-by-3 circuit takes the 3 MHz signal from the oscillator and uses Q2 as a buffer amplifier to supply a 3 MHz signal at the proper level to the input of the divide-by-3 integrated circuit, U2. U2 divides the 3 MHz signal by 3 and produces the 1 MHz signal use by the counter.



U1, 3MHz OSCILLATOR ASSEMBLY, B39487R1



U1, 3MHz OSCILLATOR SCHEMATIC, B39490R1

3 MHz OSCILLATOR AND POWER SUPPLY PARTS LIST

Ref.	Description	SD Part No.
	3 MHz Oscillator and Power Supply Assembly	B39487A
	3 MHz Oscillator and Power Supply Schematic	B39490A
C1	Capacitor, 100 pF, 500 V, 5%	C0536
C2	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4005	CR0284
CR2	Diode, 1N4005	CR0284
CR3	Diode, 1N4005	CR0284
CR4	Diode, 1N4005	CR0284
Q1	Transistor, 2N4921	Q0267
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.1 k, 1/4 W, 5%	R0693
R2	Resistor, 27 k, 1/4 W, 5%	R0824
R3	Resistor, 20 k, 1/4 W, 5%	R0964
R4	Resistor, 6.8 k, 1/4 W, 5%	R0696
R5	Resistor, 5.6 k, 1/4 W, 5%	R0821
R6	Resistor, 1 k, 1/4 W, 5%	R0765
R7	Resistor, 1 k, 1/4 W, 5%	R0765
R8	Resistor, 5.6 k, 1/4 W, 5%	R0821
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, 7473N	19709
	Heatsink	A39486

OPTION 15
DECADE INDICATORS (E)

The E Option adds one readout digit to the standard instrument. When adding option E, remove and add one each jumper wire as shown on drawing D33997.

Parts List

Ref.	Description	SD Part No.
U51	Integrated Circuit, SN7441N	19707
U52	Integrated Circuit, SN7075N	25731
U53	Integrated Circuit, SN7090N	25732
V8	Tube, Readout, NL5859S	V0131

OPTION 16
DECADE INDICATORS (EE)

The EE Option adds two readout digits to the standard unit. When adding option EE, remove one each jumper wire as shown on drawing D33997.

Parts List

Ref.	Description	SD Part No.
U51	Integrated Circuit, SN7441N	19707
U52	Integrated Circuit, SN7075N	25731
U53	Integrated Circuit, SN7090N	25732
U54	Integrated Circuit, SN7441N	19707
U55	Integrated Circuit, SN7075N	25731
U56	Integrated Circuit, SB7090N	25732
V8	Tube, Readout, NL5859S	V0131
V9	Tube, Readout, NL5859S	V0131

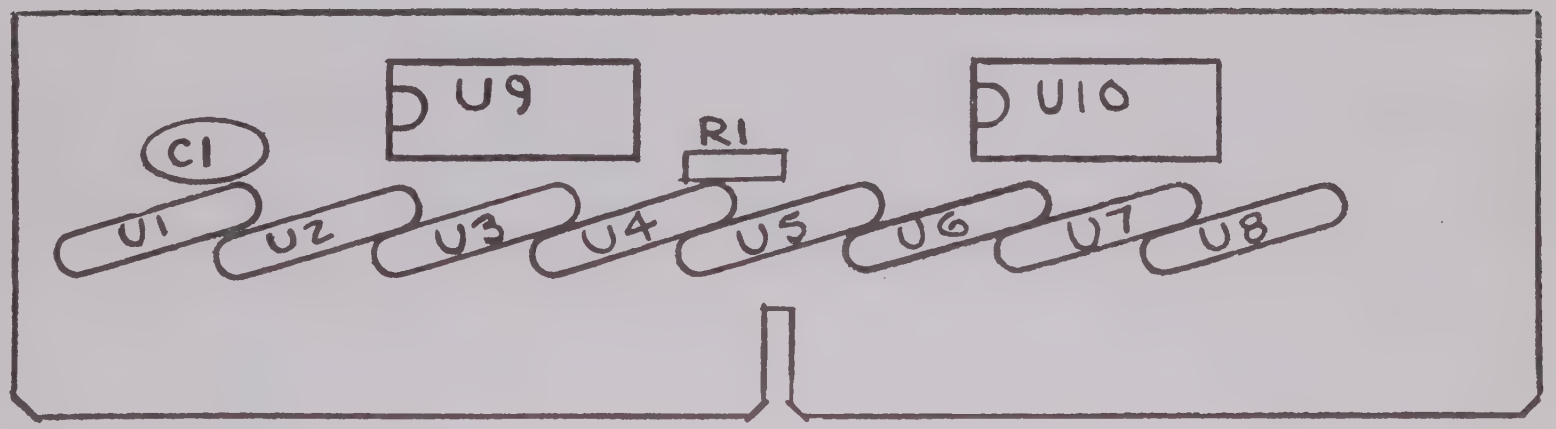
OPTION 17
DATA OUTPUT (D3)

BCD pin assignments:

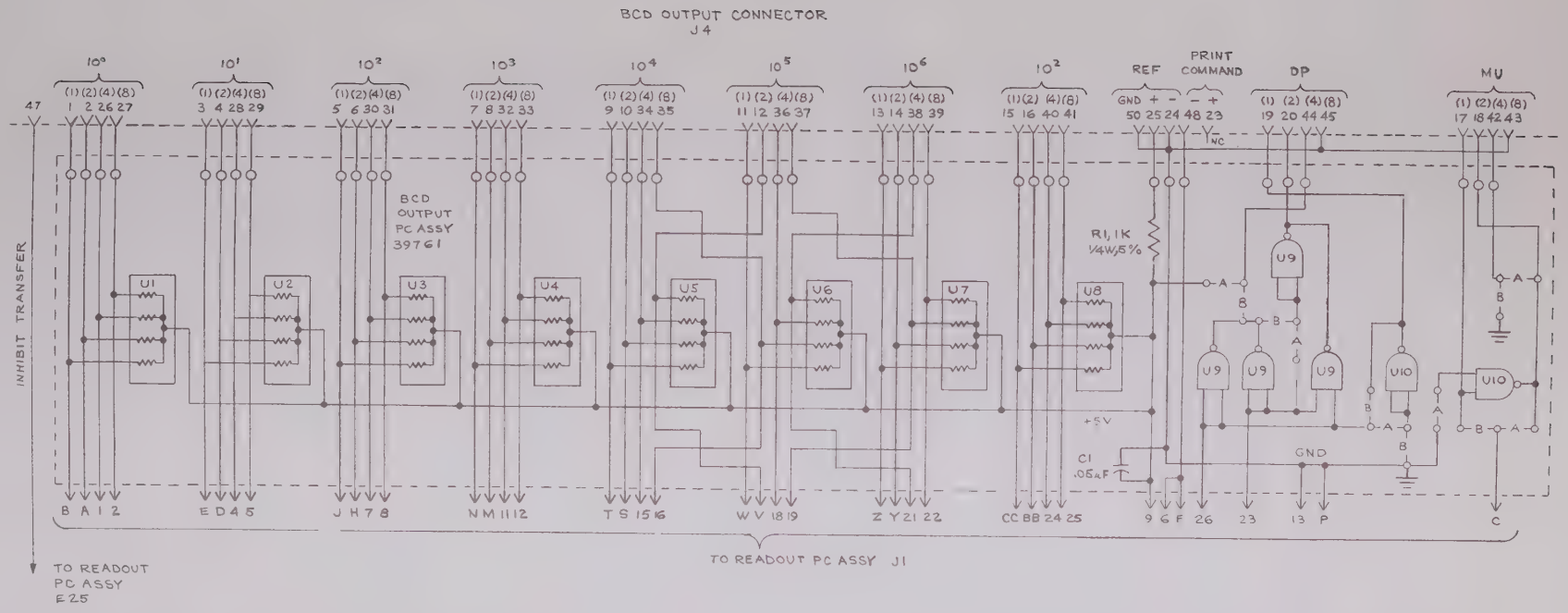
DIGIT DISPLAYED	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	2	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41
ANNUNCIATION		
Measurement Unit	1	17
	2	18
	4	42
	8	43
Decimal Point	1	19
	2	20
	4	44
	8	45
RECORDER CONTROL		
+ Reference		25
- Reference		24
Instrument Ground		50
Print Command *		48
Inhibit Transfer		47

* 0 → +15 volt transition at end of count.

J4 (BCD OUT) Connector = Amphenol 57-40500
Mating Connector = Amphenol 57-30500



OPTION 17 (D3) BCD ASSEMBLY A39897B



		1	2	4	8
DP	10^0	0	0	0	0
	10^1		0	0	0
	10^2	0	1	0	0
	10^3	1	1	0	0
	10^4	0	0	1	0
	10^5	1	0	1	0
	10^6	0	1	1	0
	10^7	1	1	1	0
MU	MHz	1	0	0	0
	KHz	0	1	0	0
	μS	1	0	1	0
	mS	0	0	1	0
	SEC	1	1	0	0

NOTES

1) U1 THRU U8 ARE 5K, 1/10W, 20% RESISTOR NETWORKS 27867
2) U9 & U10 ARE SN15846N OR EQUIV. PIN 7 GND, PIN 14 +5V
3) JUMPERS 0–A–0 INSTALLED FOR MODELS 6052 & 6053
4) JUMPERS 0–B–0 INSTALLED FOR MODELS 6050 & 6051

OPTION 17 (D3) BCD SCHEMATIC C39113B

OPTION 17 (D3) BCD PARTS LIST

Ref.	Description	SD Part No.
	BCD Output Assembly	A39897B
	BCD Output Schematic	C39113B
C1	Capacitor, .05 µF, 12 V, Disc	C0762
J4	Connector, 50 Pin	J0170
R1	Resistor, 1 k, 1/4 W, 5%	R0765
U1	Resistor Network, 5 k, 1/10 W, 20%	27867
U2	Resistor Network, 5 k, 1/10 W, 20%	27867
U3	Resistor Network, 5 k, 1/10 W, 20%	27867
U4	Resistor Network, 5 k, 1/10 W, 20%	27867
U5	Resistor Network, 5 k, 1/10 W, 20%	27897
U6	Resistor Network, 5 k, 1/10 W, 20%	27897
U7	Resistor Network, 5 k, 1/10 W, 20%	27897
U8	Resistor Network, 5 k, 1/10 W, 20%	27897
U9	Integrated Circuit, SN15846N	19716
U10	Integrated Circuit, SN15846N	19716
P4	Connector, 50 Pin	J0171

OPTION 20
REMOTE OPERATION (P)

Remote control pin assignments:

PIN NO.	CONTROLS
1	Inhibit Reset
2	Reset (closure to ground will reset instrument only when gate is closed.)
4	FUNCTION "B"
5	FUNCTION "C"
6	FUNCTION "D"
8	RESOLUTION "B"
9	RESOLUTION "C"
10	RESOLUTION "D"
12	+5 V
14	Ground

DESIRED FUNCTION	GROUND PINS	DESIRED RESOLUTION	GROUND PINS
ACTO	4 & 6	10^{-1}	NONE
TEST	6	1	8
X1	NONE	10	9
X10	4	10^{2}	8 & 9
X100	5	10^{3}	8 & 10
X1000	4 & 5	10^{4}	9 & 10
		10^{5}	8, 9, & 10

J4 (REMOTE CONTROL) = Amphenol 57-40140
Mating Connector = Amphenol 57-30140

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